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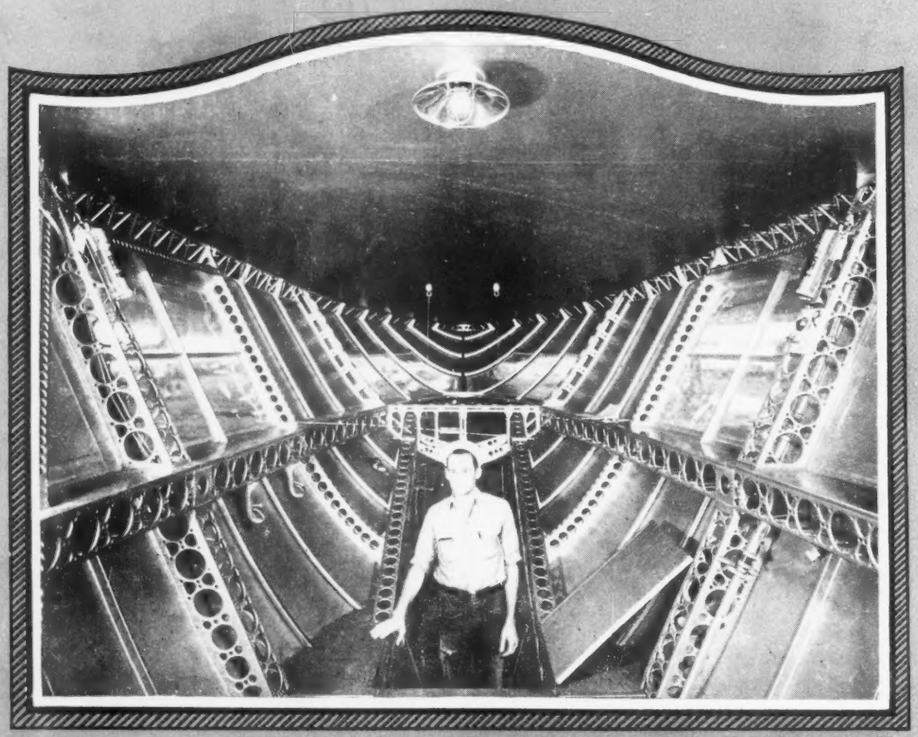

Keystone View Company, Inc.

WHERE THE "AKRON" HOUSES HER STING—THE GUN ROOM OF THE UNITED STATES NAVY'S NEWEST AND LARGEST AIRSHIP

Liquid Gold of the Canary Islands
F. H. Storms

Bed of Former Canal to Serve as Subway Route
R. S. Gregg

Pioneer Railway of Our Northwest
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America's Wonder River—The Mighty Colorado
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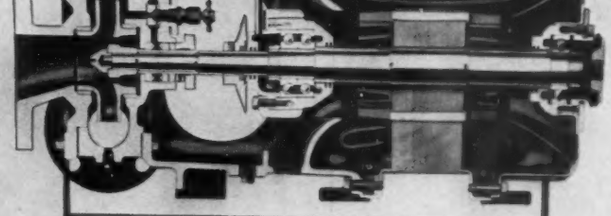
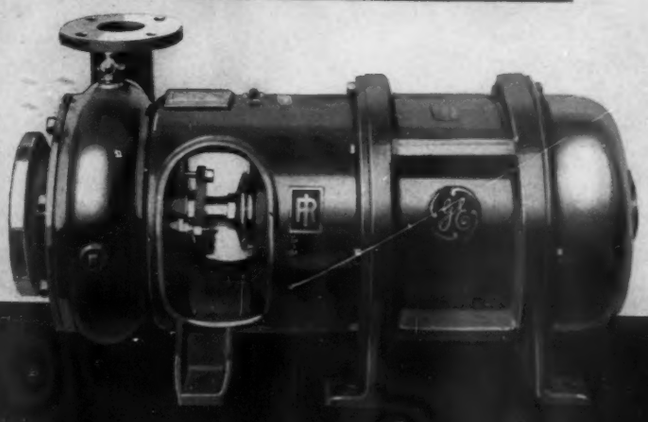
The Cameron

MOTORPUMP

An Ingersoll-Rand Product

A new idea in pumps worth looking into





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As It Seems To Us

FILIPINOS USE MORE OF OWN SUGAR

HOW, when, and why we became the world's greatest per capita consumers of sugar is not of present interest save that it was probably the outcome of an available plenty. Sugar is an energy-producing foodstuff, and scientists have pointed out at various times that our national initiative may, to a degree, be due to this fondness for sweets.

If the foregoing assumption be correct, then there is something significant in the news item that recently appeared in the press regarding a marked increase in the consumption by the Filipinos of their own sugar. This is attributed to changes in the living standards of the people of the Philippines. It seems that the quantity of sugar used in the islands has more than doubled in the course of six years; and this development of the domestic demand is likely to lead, if continued at the present rate, to a local consumption of 150,000 long tons annually.

The Philippine Islands are admirably suited for the growing of sugar cane; and the production of sugar has been a steadily augmenting source of income. However, prosperity in that field of industry has been dependent upon a ready foreign market. The United States bought last year about 730,000 tons; and the business in the islands has looked forward to thus disposing yearly of 1,000,000 tons—in fact, that has been its objective. If a tariff should be placed by the United States on raw sugar, as some fear, then the Philippine grower might have to look for another way to dispose of his excess. If such should be the case, then the greater use of sugar among the Filipinos, themselves, may be the means of saving the day.

THE TIDE HAS TURNED

WE HAVE it on the authority of recognized experts that the economic tide has turned and that the wheels of industry are once more speeding up. At least, there is ample warrant that the slack water after the distressing ebb has ended, and that the flood tide has set in in some parts of the country and in some of our fundamental productive activities. This is heartening news and should cause rejoicing from end to end of the land.

Reviewing the pronouncements of persons of prominence, made public during the past six months, is enough to fill the mind of the average man with bewilderment when seeking a reason for the slump that has hit most of our accustomed activities. Perhaps all the causes mentioned have had something to do with the economic mess in which we have found ourselves; but, viewing the situation from the fence, the reputed leaders have appeared not unlike a milling crowd sorely in need of someone with sufficient initiative to guide them into an open highway leading to a real goal. It has been a spectacle of protracted hesitation, if not fear.

Assuming that the tide has turned definitely toward better things, still the strength of that movement will depend in large measure upon the confidence not only of those at the head of affairs but of the populace at large. We therefore quote two paragraphs from a statement recently issued by the President's Organization on Unemployment Relief:

"While it may be true that final complete recovery from the depression must await removal of adverse world conditions, it is certain that we delay recovery by passively accepting our relation to the international situation and in failing to make a concerted, determined, effort to correct domestic conditions.

"As the most nearly self-contained nation, we have within our own boundaries the elemental factors for recovery. Our national wealth, even stripped of the inflated value foolishly placed upon it, still is greater than our pre-war wealth; it is greater, too, than it would have been under any normal increase between 1914 and 1931. The overwhelming volume of our domestic business in comparison with export trade places us in position to develop internally a constructive recovery if we grasp the opportunity which still is ours."

Let us get a firm hold on that opportunity, and prosperity will be ours.

HAS OVID'S GRAVE BEEN FOUND AT LAST?

POSSIBLY COLUMBUS was buried in San Domingo, despite those historians who have stated to the contrary. Tradition has it that MAHOMET'S coffin was suspended between heaven and earth—where, there is room for doubt. The same uncertainty has hung about the final resting place of OVID, that brilliant Roman poet who managed somehow in his writings to give offense to the imperial household and to win thereby banishment.

While the form of his banishment was of the mildest sort—leaving him in possession of his property and not depriving him of his civic rights, still it entailed his living in the semi-barbaric Town of Tomi and far from the cultured environment to which he was accustomed. It is a matter of history how, in the isolation of that half Greek community, the poet tried valiantly to console himself by practising his art. In that way, he hoped but in vain to appease the wrath of the throne and to gain pardon and return to Rome. He died sad at heart in exile.

OVID'S death occurred in 17 A.D., and in the centuries following no one apparently has been able to ascertain where he was interred other than that it was before the gates of Tomi. Now, so the *New York Times* reports, a Rumanian cryptologist, E. C. GRIGORASH, has discovered the place where all that remains of OVID reposes. The sarcophagus bears a succession of objects which, when arranged in vertical order, spell OVIDIUS. This sarcophagus stands in the modern City of Constanza, once Tomi, and was unearthed within the current year.

AN EFFICIENT NAVY

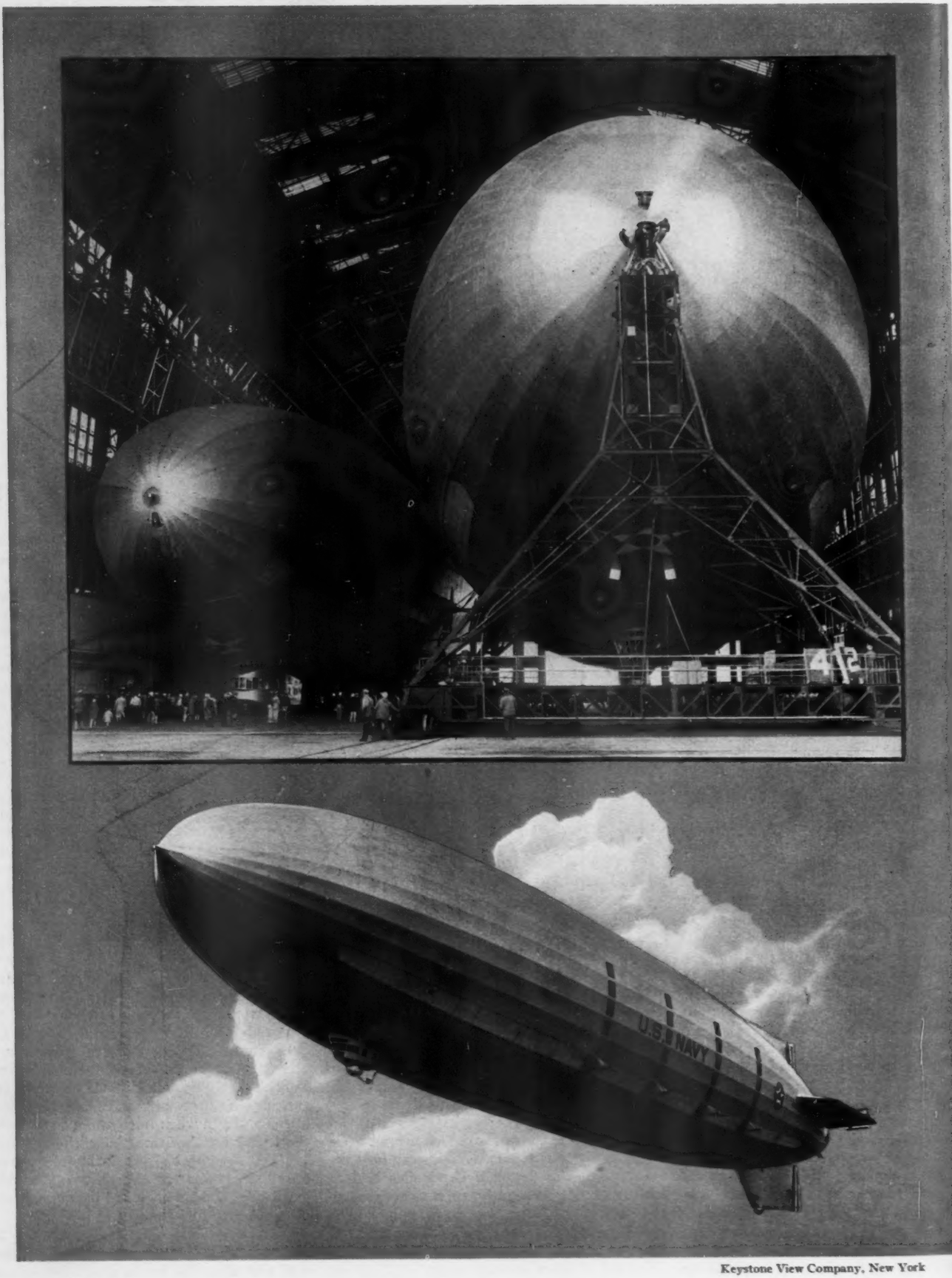
FAR be it from us to enter into a discussion that is likely to have plenty of participants before the din ceases. It is unfortunate that the representative of any organization should speak disparagingly of our Chief Executive all because the President and the organization in question do not see eye to eye.

No doubt, every red-blooded American wants to see the United States in possession of a navy capable of protecting the country from attack by any potential enemy; but who among us is qualified to state conclusively of just what such a fighting force afloat should consist to meet that specification? Having been committed by international agreement to a reduced force—stated broadly in terms of types and displacements, no two naval experts, commissioned or civilian, are likely to agree when viewing the problem from opposing sides.

Modern battlecraft are extremely complex structures; and the naval constructor and the marine engineer, between them, can do a deal of juggling in turning out, upon a given displacement and a given number of guns, ships that may differ greatly in their military characteristics of speed, defense, and powers of offense. If you know exactly what your adversary is going to build, then you can so arrange the distinctive features of your own craft that it may be undeniably superior in certain circumstances. On the other hand, your potential adversary may do the same if he finds out soon enough just what you intend to build.

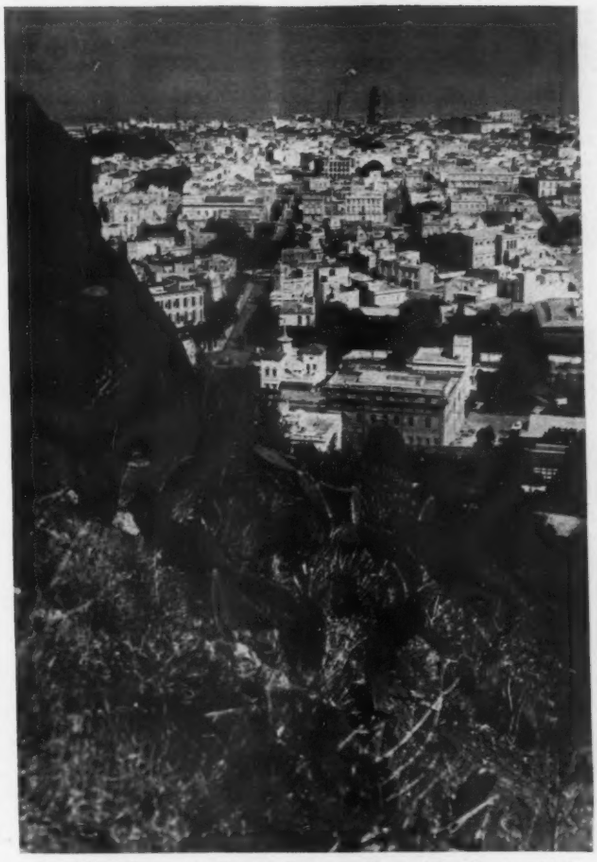
In any case, a variety of deductions can be arrived at from available facts and figures; but there may be an additional unknown factor that will upset any and all of these conclusions. Even when the fighting tools of two contenders are the same, the spirit, the training, and the acquired expertness of one may completely outmatch the other. This idea is not new; and we have had it strikingly emphasized time and time again in warfare.

We shall stand on the sidelines when the gentry in Washington are arguing pro and con; and when the battle of opinions ceases, the people at large will probably find the nation reasonably safeguarded, no matter who wins.



Keystone View Company, New York

The "Akron", the United States Navy's newest dirigible during her maiden flight and after she reached her home station at Lakehurst, N. J.



Looking down on Santa Cruz de Teneriffe, the capital of the Western District of the Canaries.

Liquid Gold of the Canaries

The Economic Future of These Delightful Islands Is Largely Dependent Upon Increased Supplies of Fresh Water

By FRANK H. STORMS

HOMER wrote that the Canary Islands, as we call them today, were discovered and colonized by the Egyptians as far back as 1400 B. C. It is also believed by some historians that the Canaries were the *Insulae Fortunatae* of the Romans. Be this as it may, there is no denying that the islands have been favored by nature in many ways.

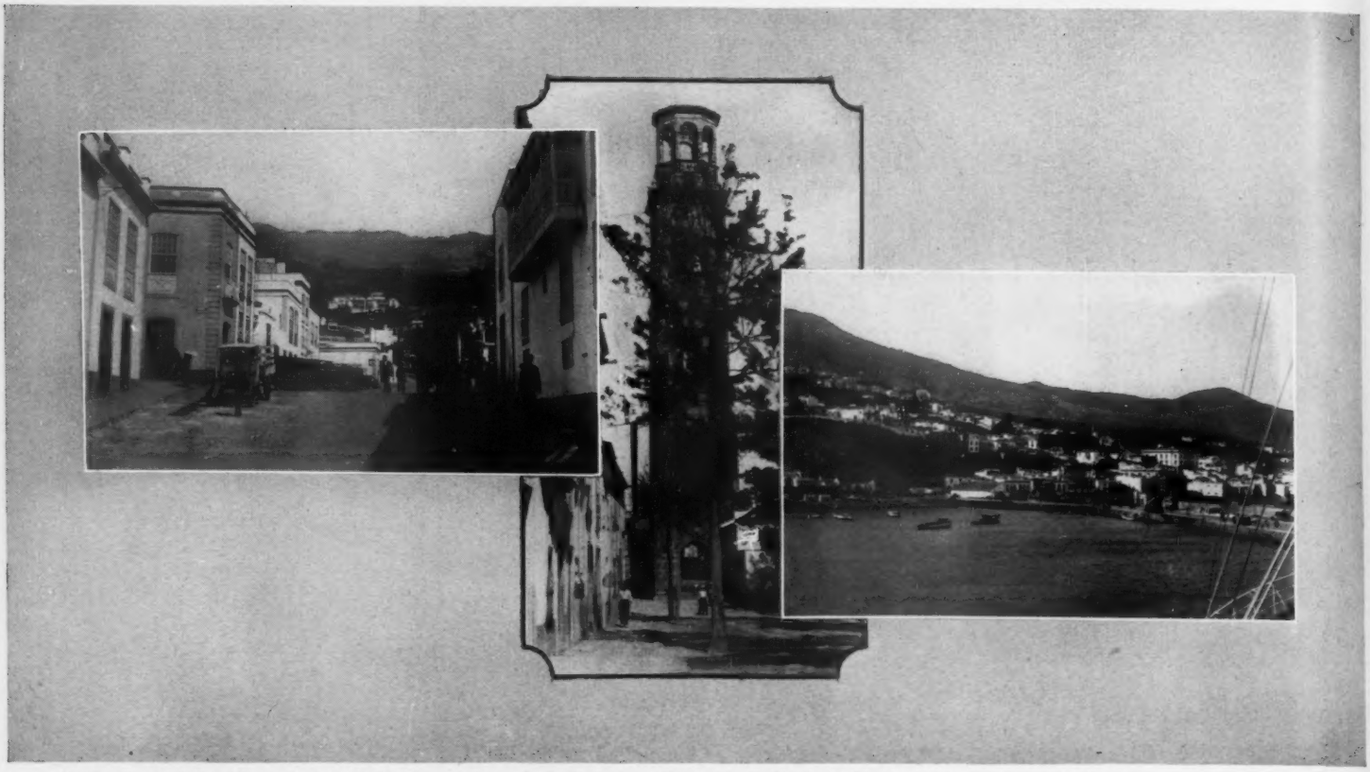
The Canary Islands are manifestly of volcanic origin; and more than one imaginative author has concluded that when fabled Atlantis sank beneath the waves the Canary Islands, by the same seismic disturbance, rose above the sea. Not only are there ample evidences of volcanic action among the group, but the towering peak of El Teide, on the Island of Teneriffe, even now emits occasional puffs of steam that testify to the intensity of the heat still at work in the bowels of that volcano. The Guanches, the early inhabitants of the group, named the mountain El Teide, which means hell. Just the same, that titanic cauldron is a blessing. The peak rises to a height of 12,192 feet; and it is the continual melting of the snow that falls upon the floor of the crater that furnishes a never failing source of water—truly liquid gold in the islands.

The Canaries are composed in the main of seven islands which, for political reasons, are divided into two districts—the Eastern and the Western. Together, they have an aggregate area of 3,108 square miles and a combined population of a little more than 493,000. Las Palmas is the capital of the Eastern District, and Teneriffe is the capital of the Western District. The Canaries lie in the sweep of the Gulf Stream; their rugged volcanic hills are fanned by well-nigh ceaseless breezes; and the climate is a delightful one—a considerable range of temperature being obtainable at any season by a simple change of altitude. The sun shines nearly 292 days annually. The minimum temperature in the coastal towns is a trifle less than 50° F.; and the maximum temperature seldom exceeds 88° F. To the leisurely minded, the Canary Islands offer an ideal place in which to live. They were created a province of Spain in 1821, after they had been under Spanish rule from the latter part of the fifteenth century. The islands are ports of call for the vessels of many maritime nations; and Las Palmas, on Grand Canary, has long been an important coaling station.

Leaving out the matters of doubtful historical foundation, it is well established that the islands were attacked by the French in 1344 and by the Spanish in 1393; but the Guanche kings were able to repulse the invaders. Not until 1496 were the Spaniards able to achieve the subjugation of the natives, and then their success in this was due principally to the ravages of a plague that seemingly did not affect the invaders. The Canaries have remained under Spanish dominion ever since. Even so, the Canarian of today feels that he is first a Canarian and then a Spaniard.

Santa Cruz de Teneriffe is justly proud of the fact that she repulsed the indomitable Admiral Nelson during an attack on the port in July, 1797—the only defeat suffered by him in the British-Spanish war. The famous admiral lost an arm during the engagement; and today, in the Museo Nacional, may be seen the bronze cannon, bearing the name El Tigre, which is said to have fired the wounding shot. History has it that the Spaniards, after that victory, gave each of the enemy's men a loaf of bread and a bottle of wine—evidence of their hospitality and of the traditional sportsmanship of the British.

The inhabitants of the Canaries, because of the location and formation of the group, have always had a struggle to make a living, especially so in the days when trading with the outside world was unknown or in its infancy. It was then a case of cultivating the comparatively small patches of fertile soil and of hoping for sufficient rain to bring the crops to maturity, or of fishing for a livelihood. So afraid of over-population were the natives at that time that a man was liable to be put to death for merely joining or



Left—One of the "busy" streets in Santa Cruz de la Palma. Center—Calle de la Noria in Santa Cruz de Teneriffe. Right—Santa Cruz de la Palma, like the other island cities, nestles on a hillside.

speaking to a strange woman on a public road.

This situation changed with the passing years as increasing numbers of vessels visited the islands and opportunities for trade developed. This trade was for the most part dependent on agricultural products, a field of endeavor in which the Canarians were much handicapped by a semi-arid climate. As early as two years before the discovery of America, we are told, British traders resident on the islands were buying the sugar produced there. For a time the industry flourished, only to be wiped out in the beginning of the sixteenth century as the result of competition with the West Indies. In the place of sugar the natives took up the cultivation of the grape, a business which appears to have reached its peak in 1804 when wines and brandy were exported principally to British North America. Though the vine thrives in the volcanic-ash soil of the hillsides, and the product has a reputation for excellence, this industry, too, has dwindled to but a small fraction of its former volume because of the keen competition offered by wines from France and Spain.

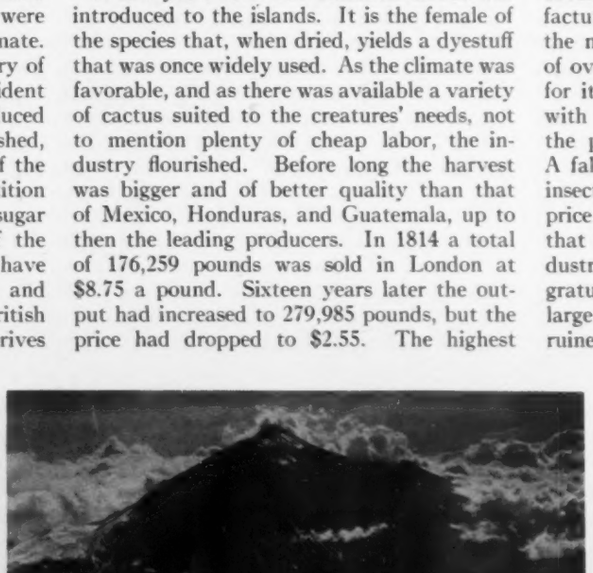
The resourceful Canarians next turned their attention to the growing of a plant indigenous to the islands—to the *mesembryanthemum* or ice plant, which yields a soda suitable for glass-making. The story goes that a priest from the Island of Lanzarote, who was seized by the Moors in 1742, learned from his captors the art of extracting soda from the ashes of the ice plant. This knowledge he in turn imparted to his countrymen upon his return after effecting an escape. For years they exported this commodity to their profit. About 1810, however, the trade slumped, and was finally abandoned when it was found that soda could be extracted from sea water.

A few years later the cochineal insect was introduced to the islands. It is the female of the species that, when dried, yields a dyestuff that was once widely used. As the climate was favorable, and as there was available a variety of cactus suited to the creatures' needs, not to mention plenty of cheap labor, the industry flourished. Before long the harvest was bigger and of better quality than that of Mexico, Honduras, and Guatemala, up to then the leading producers. In 1814 a total of 176,259 pounds was sold in London at $8.75 a pound. Sixteen years later the output had increased to 279,985 pounds, but the price had dropped to $2.55. The highest level was reached in 1869, when production amounted to 6,076,869 pounds valued at $0.65 a pound. This meant an income from cochineal alone of about $14.70 for every one of the 270,000 inhabitants of the Canaries.

By this time analine dyes had been discovered, but they were not yet being manufactured on a commercial scale. However, the natives began to be worried, and talked of over-production of cochineal and of means for its prevention. A company was formed, with a large capital investment, to regulate the placing of the dyestuff on the market. A false rumor of the "drowning out" of the insects by heavy tropical rains raised the price of the cochineal but, unfortunately, also that of the aniline dyes, giving the latter industry a big impetus. Merchants who congratulated themselves on the high price their large stocks would bring were eventually ruined when the best quality of the dried insect went for as little as $0.22 a pound.

Years of hardship and of poverty followed, during which unsuccessful attempts were made to replace the cochineal with the growing of tobacco. The extensive cultivation of tomatoes, potatoes, and bananas was subsequently tried, bringing us down to the present in which the raising of bananas is by far the most important industry—the islands of Teneriffe and Grand Canary being the largest producers. British initiative has done much to bring about the success that has been achieved in this direction.

For the growing of bananas a great deal of water is required, and since



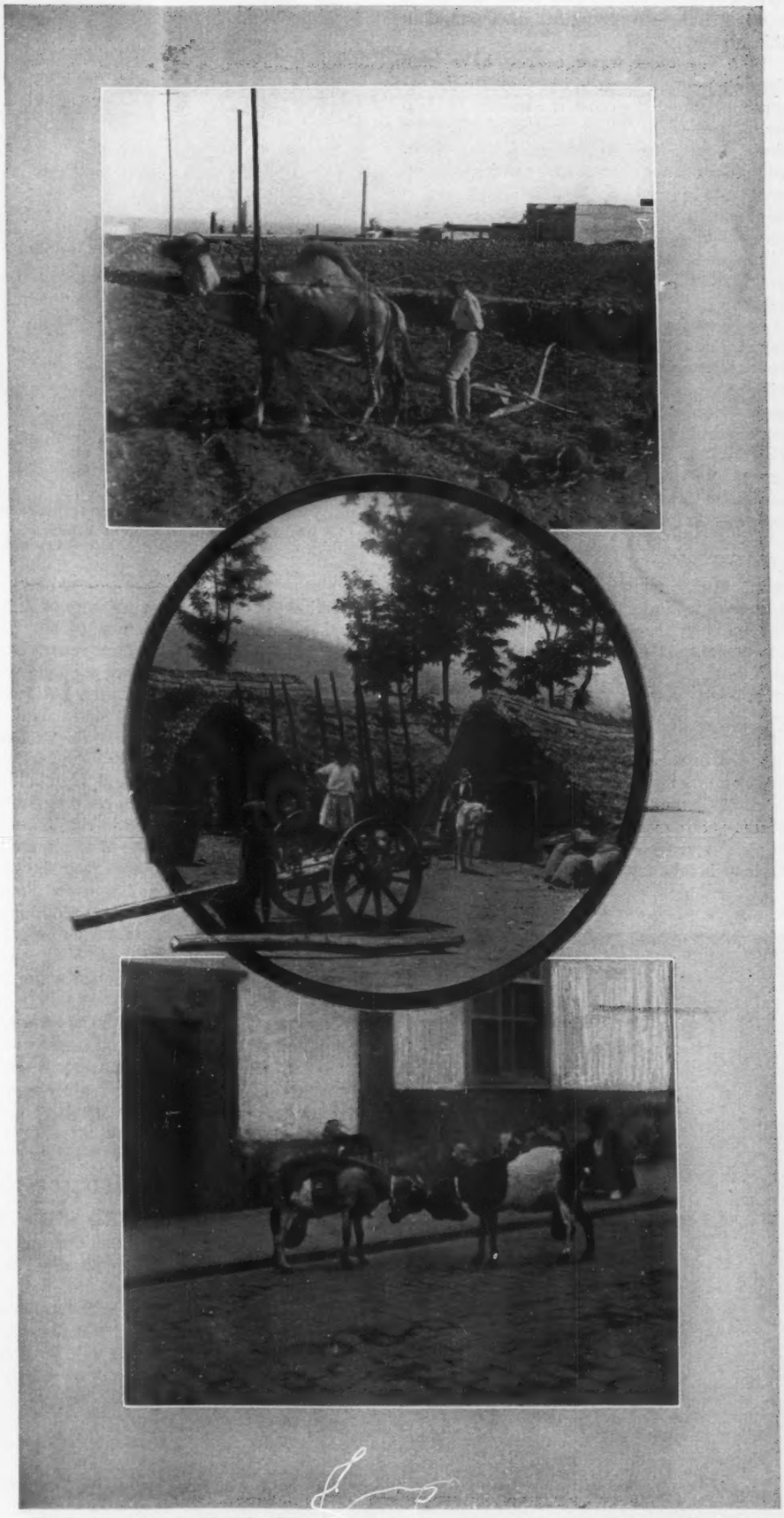
The summit of El Teide, the towering volcano on the Island of Teneriffe that furnishes its inhabitants with water.

the islands are entirely volcanic and, of course, wholly devoid of ground-water-carrying sandstones, the rainfall has a quick run-off to the sea except where artificial means have been provided to impound it. However, a large amount of ground water, seeping down along the footwalls and hanging walls of dikes, collects much as in the case of stratified limestone, clay, sandstone, etc. These dikes are later intrusions in the basaltic country rock, and have generally steep slopes or dips of as much as 90°. Rain water filters down their sides, accumulating along the walls in beds of cinders or volcanic tuff.

When it was learned on the Island of Teneriffe that there was every likelihood of striking water by cutting through these dikes, the natives promptly began to form *comunidades;* and then and there a tunnel-driving boom was started. Three or four people would get together and decide to drive a tunnel in a certain place. To raise the sum needed for this work, perhaps 40,000 or 50,000 pesetas, shares or equal water rights would be sold having a certain par value, say 500 pesetas. Drilling equipment would then be purchased and operations begun. If the funds ran low before the project was finished, each member of the *comunidad* was assessed according to the number of shares he held, often amounting to only a few pesetas a month to pay for the cheap labor and the fuel required. When water was struck, the value of a share would skyrocket, and it was commonly the best policy to sell out as soon as possible because the supply was usually a diminishing one. In one case the 500-peseta shares are said to have soared to 50,000 pesetas each because the volume of the flow proved large and continuous.

The early days of the boom witnessed the purchase of numerous Type Twenty portable compressors, some stationary ER compressors, and always the rugged "Jackhamer" in preference to the more powerful column-mounted drifter rock drills. Later, when the boom subsided, the *comunidades* abandoned tunnel driving under their own direction; and since then they have been awarding this work to a few experienced contractors who have accepted it at fixed prices—a more satisfactory arrangement all around.

On the Island of Grand Canary the situation is different. There the water rights to every spring, rivulet, or gulley freshet have been owned for generations. A water right to a small spring that years ago belonged to perhaps but one man is now divided and subdivided into such small parts that one shareholder may be privileged to draw water from it for his land for a period of but fifteen minutes once a month. It is a fact that some water rights are participated in by every family in the particular village or community. Any attempt to drive a tunnel through existing dikes is out of the question: the members of the *heredamientos* will not permit it. They fear that the use of explosives anywhere near the source or the course of their water may "scare away" rather than augment the flow, and the result is general opposition to such a step. Laws have been passed by these selfsame people—almost all of whom own or



Typical rural scenes in the Canaries where the camel is used as a draft animal and where goats are taken from door to door to furnish the daily supply of fresh milk.

have a relative who owns a small interest in a water right—to strengthen their stand in this matter.

In a few cases water tunnels have been driven on Grand Canary, but they are the exception. Along the coast the sinking of deep wells is allowed. These usually consist of a shaft about 5 feet square and 75 feet deep, and almost always strike water which is, however, largely brackish. Windmills are used to elevate it for distribution over relatively small areas of farmland given over to the growing of tomatoes. After four or five years the soil so irrigated becomes unfit for further cultivation.

And now for a few facts regarding the banana industry. A *fanegada*—a piece of land a little more than 1.3 acres in size, when planted with 3-year-old banana trees and within reach of an ample supply of water, is worth anywhere from 60,000 to 120,000 pesetas. The par value of the Spanish peseta is equivalent to 19.3 cents in United States currency; but at the present time it has depreciated to less than half that amount. Such an area, if the land be good, will produce from 800 to 1,000 and even as high as 1,200 bunches a year. If the plantation be low-lying—that is, close to sea level, it will yield on an average three crops a year; but at higher altitudes it takes from five to seven months for the fruit to come to maturity. Each bunch sells for from 10 to 25 pesetas, or brings an average price of fifteen pesetas.

The pleasure-seeker can find much in the Canaries to make a visit there worth while. The climate is a bracing one, the beaches are fine, and the mountains offer a lure to the climber and satisfaction to the lover of beautiful scenery. There is a fair number of excellent hotels; and good wine can be had at the modest outlay of fifteen cents for a quart bottle! No tourist should fail to see the famous dragon trees from which is obtained a dark, red-brown resin known as dragon's blood. This resin is used variously, but principally for coloring varnishes and lacquer. There is one in the *patio* of the Pino de Oro Hotel, at Santa Cruz de Teneriffe, which is said to be 2,000 years old; and Humboldt, the famous German naturalist, estimated the age of one that formerly stood in the Villa de Oratava at 6,000 years. This aged monarch was destroyed by fire a few years ago. Camels are used as pack animals and to draw plows in many parts of the islands; and the milkman, who depends upon goats for his supply, drives his creatures to the customer's door and there delivers the product absolutely fresh.

Those who visit the islands with the thought of enjoying them after the happy fashion set by the natives will find the Canarians and the relatively few foreign residents always ready to extend a warm welcome and the hospitality of that attractive region.

In holiday attire. Canarians participating in the potato feast which is held after a typical island dance.

At night in the patio of the Hotel Pino de Oro showing the famous 2,000-year-old dragon tree.

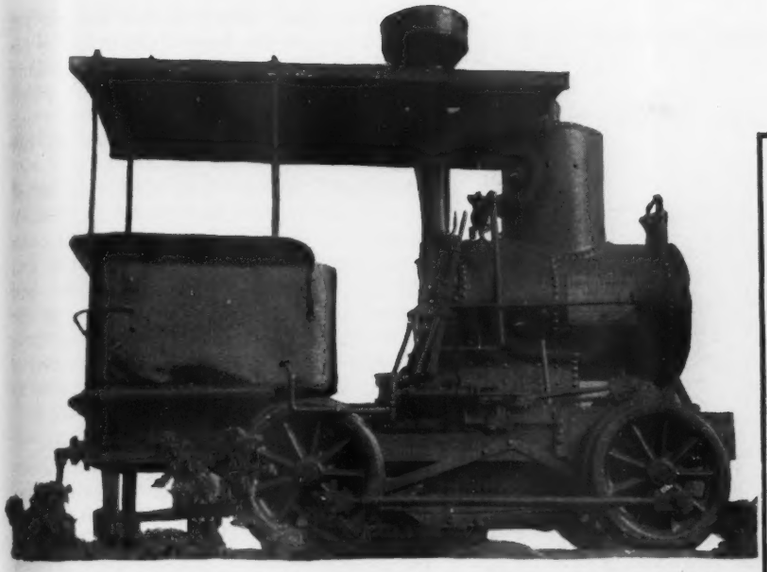
POSSIBILITIES OF POWDERED METALS

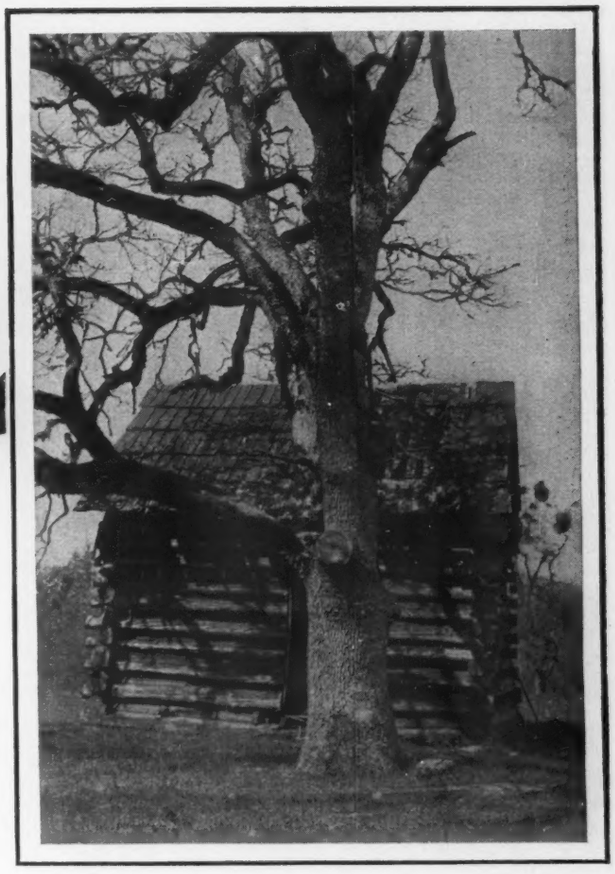
THAT there is a big future for powdered metals is predicted by those that have been following the trend of that phase of the metallurgical industry. Today, the list of pulverized metals utilized for industrial and decorative purposes includes substantially all the ordinary run of metals as well as precious metals; and within the year have been developed processes for reducing nickel, monel metal, chromium, platinum, and palladium anywhere from the coarseness of granulated sugar to the fineness of talcum powder. In these forms they can be applied by the spray method to coat metal or other surfaces, or can be added to molten metals or other substances to produce a wide variety of alloys, bearings, paints, inks, etc., etc.

Already, there is a demand for from 2,000,000 to 3,000,000 pounds of pulverized copper annually. Powdered copper, nickel, and tin enter into the manufacture of porous-metal bearings that are surprisingly strong and are capable of holding from 4 to 6 per cent of their own weight in lubricants. Bearings of this kind for automobiles have made 20,000,000 revolutions without becoming dry. A mixture of powdered nickel, cobalt, and charcoal produces the pencils for sunlight lamps; powdered silver is used in making controls for electric signals; and large quantities of pulverized permalloy, consisting of 20 per cent iron and 80 per cent nickel, are consumed in turning out parts for electrical equipment. The same material is also said to have improved long-distance telephonic communication considerably without adding to the cost of the service.

Many more applications of powdered metals could be cited, but enough have been mentioned to give an idea of their diversity and of what has already been done in this department of the metallurgical industry, which is only in its infancy. The prospects are that powdered metals, if investigations now in hand are successful, will make it possible to accomplish things that are now unattainable with present-day means and methods.

Coincident with the announcement that the Goodyear Tire & Rubber Company has perfected a rubber-cushioned wheel for railroad use, it is reported that the Canadian Pacific, as the result of satisfactory experiments, is providing all its new passenger and freight equipment with rubber shock and noise absorbers. The wheel developed by the Goodyear Company has undergone rigorous testing on the Akron, Canton & Youngstown Railway. Aside from the added comfort thus assured, the wear and tear on the rolling stock and roadbed is said to be much reduced.





The "Oregon Pony", the first locomotive to operate in that state. Right—Typical homestead of the early settlers of our Northwest

Pioneer Railway of Our Great Northwest

How the Trail-Making Covered Wagon Gradually Gave Way to Steam Transportation in the Long Overland Haul to the Pacific Coast

By LAWRENCE A. LUTHER

IN a rude castle at Sitka, on the rocky coast of the Alaskan wilderness, Russian representatives of the old Czarist regime kept a stronghold and lightened the tedium of barter for whale oil and peltries with a lively consumption of vodka and rare old wines. A factor of the great Hudson Bay Company had a post at Vancouver, just across the Columbia from the present City of Portland, and his virtual dictatorship in the domain which has since become our Pacific Northwest was typical of the dignity and power of this largest and wealthiest of pioneer fur companies.

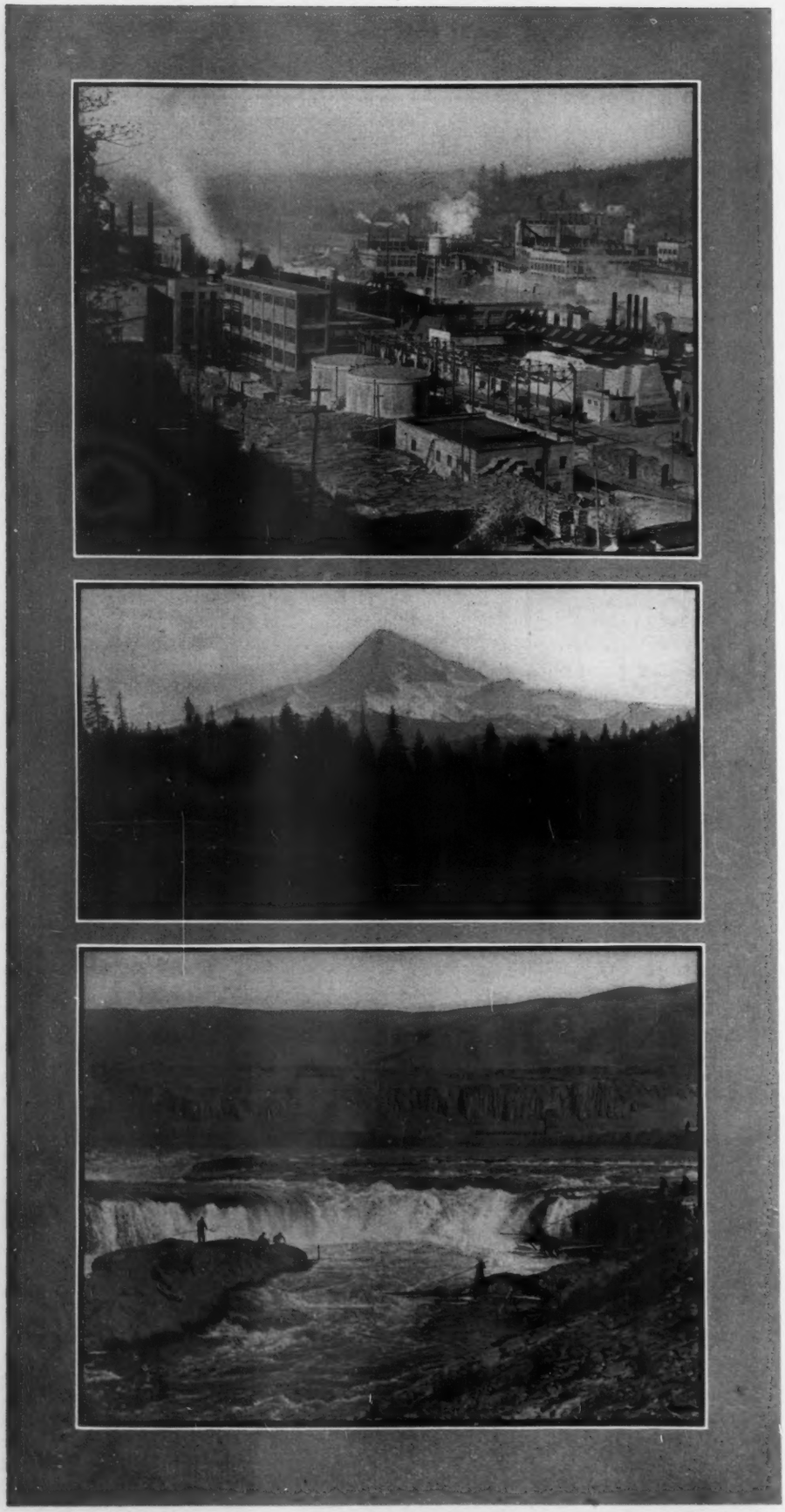
A little Spanish garrison held the Presidio beside the Golden Gate of San Francisco Bay and a Spanish governor and his entourage drowsed in the balmy air of lovely Monterey. Ardent Franciscan missionaries had built adobe missions at intervals along the El Camino Real from the Mexican border as far north as Sonoma. Those were the only representatives of government on the Pacific Coast through the early decades of the nineteenth century.

French and American trappers and traders of the Middle West talked by their camp fires of the "Western Sea". It was an intriguing subject; and the rumors and conjecturings as to its remoteness and the nature of the intervening country were as varied and vague as the rumors which had gained credence before the voyage of Columbus. Only a fraction will ever be recorded of the romance of Yankee colonization and of the courage and acquisitiveness which enabled a young and restless nation to absorb a vast territory which, in the light of transportation and communication facilities then available, appeared remote and inaccessible.

When President Jefferson secured the appropriation of $2,500 to outfit Lewis and Clark and to defray the expense of their journey, the matter was not given general publicity. The President doubted that there was sufficient popular interest in finding a trail to Oregon to warrant backing an expedition towards that end. Oregon was held in small esteem by the average citizen of the eastern states. The Hudson Bay Company was paying 10 per cent to its stockholders and was cleverly sponsoring publicity in England and America to the effect that the Northwest was fit only for wild beasts and wild men.

As late as 1843 the *London Examiner* was wondering that ignorant Americans should be disposed to quarrel over a country when the whole territory in dispute was not worth £20,000 to either party concerned; and in the same year the *Edinburgh Review* said of Oregon, "In a few years all that gives life to the country, both the hunter and his prey, will be extinct and their places will be supplied by a thin half-breed population scattered along the fertile valleys". This journal assured its readers that Oregon would never be colonized by Yankee emi-

Tracks of the Union Pacific in the scenically beautiful Valley of the Columbia River.



Top—Pulp and paper mills on the outskirts of Oregon City on the shores of the Willamette River. Center—Snow-capped Mount Hood is the highest point in the State of Oregon. It towers 11,225 feet skyward. Bottom—Indians at the falls in the Columbia skillfully netting their yearly supply of salmon.

gration overland. But Napoleon had not yet decided to curb the colonial expansion of his enemy, England, by selling us the Louisiana Purchase—the great real-estate deal which made the name of Monroe immortal and which carried our frontier westward beyond the Rockies.

Our own statesmen were almost devoid of interest in the Pacific Coast; and many thought our colonization of the region must seriously weaken our national structure and make us vulnerable to foreign invasion and internal dissension. They were sincere in the belief that we had quite enough territory, and that a wise providence had placed a great desert and the Rocky Mountains as natural barriers to any western migration.

Those among our westerners who like to perpetuate the lore of the West and to revive the old ideals of courage and loyalty as a source of every-day inspiration have given us many reminders of Lewis and Clark, the first intrepid surveyors to make a rough chart of what has become, from the standpoint both of scenic beauty and wealth of resources, our most prized possession. Our western citizens who have a flair for romance have liked especially to commemorate the patience, intelligence, and heroism of the only woman to accompany this expedition, the little Shoshone squaw, Sacajawea. Her life history at once exemplifies the stark savagery of the frontier and its aboriginal inhabitants, and levens it with typically feminine kindness and loyalty. Taken captive in a raid by the Minatarees and sold to a French guide, she performed the unbelievable feat of carrying an infant on the more than 6,000-mile round trip from the Missouri to the mouth of the Columbia—throughout much of that journey acting as expert ambassador, guide, and interpreter.

When a bill to make Oregon a territory was introduced in Congress back in 1828, a hot debate ensued, and the majority contended that the country was "of slight importance and too remote ever to become a part of the Union." It yet remained for pioneers endowed with the heroic vision of Marcus Whitman to "sell" Oregon to the Government. Relatively but a few years have passed since Whitman was toiling westward with the fondly cherished hope of getting a wagon through to the Columbia River. In imagination we can readily hear the blows of his ax as he hewed out a road, or catch his stubbornly voiced resolve to take a wagon through even when every member of his party called him a fool and begged him to be content with packing in over the existing trails. His resolution to compromise by using a cart when the wagon finally broke down beyond repair was both pathetic and sublime. But he knew full well that if the valleys were to be "filled with our people", as he so earnestly desired, he would have to nullify the propaganda of the Hudson Bay henchmen who were terrorizing emigrants with their accounts of impassable trails and hostile savages.

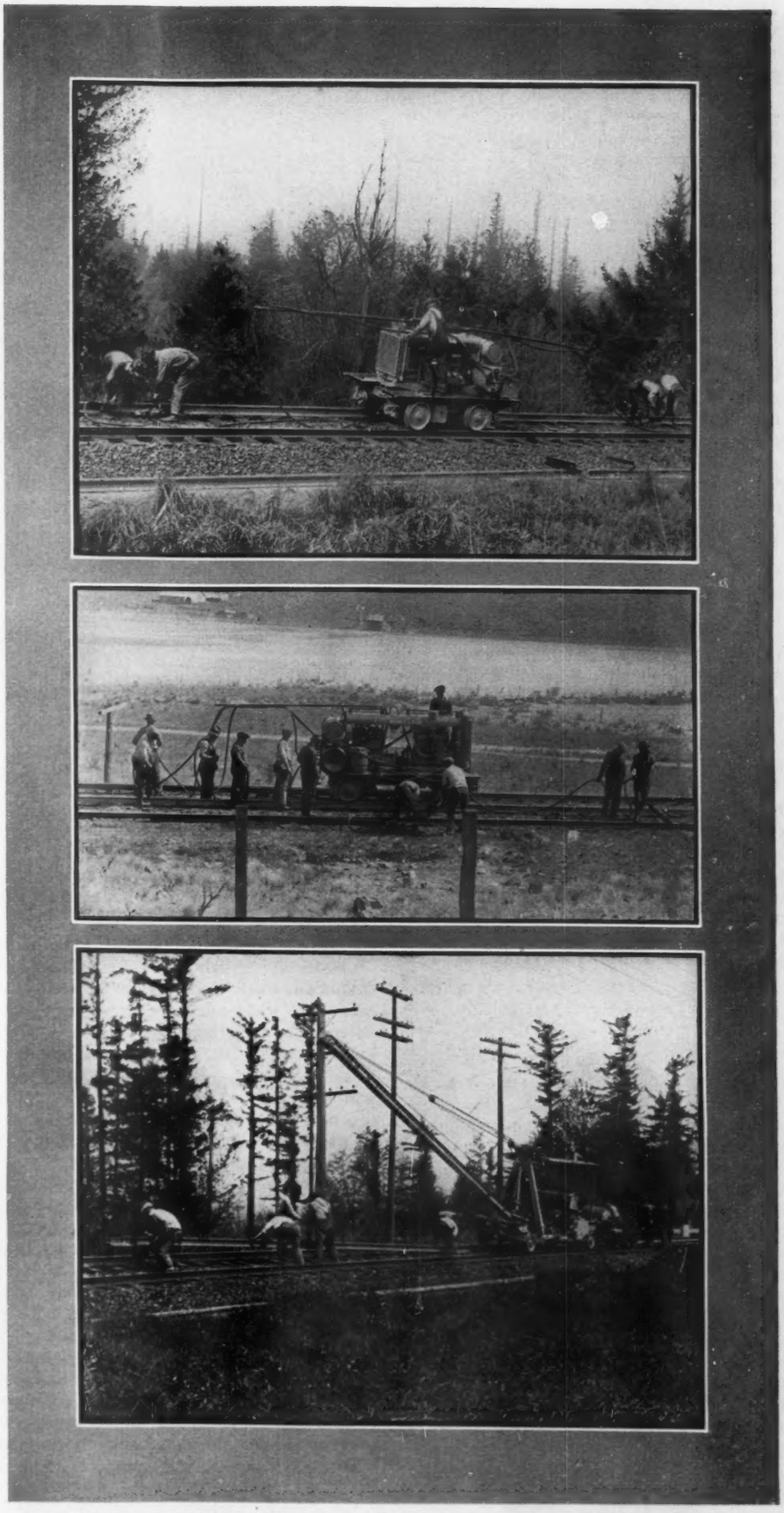
Citizens of the Northwest today are rightly proud of being the people of Whitman's envisioned empire. They like to recall his return journey to Washington in the dead of

winter by way of Taos and St. Louis, and to picture him—clad in leather and fur, ragged, frostbitten, and suffering from exposure—as he stood before Daniel Webster, Horace Greeley, and the President, and turned their indifference towards Oregon into an interest that won for his cause a measure of support. He could refute their belief that the proposed trading of Oregon for Newfoundland fisheries was putting over a sharp deal on England; and there was conviction in his promise to lead 1,000 emigrants to Oregon the following summer. From the day on which Whitman started westward with his bride and made her one of the first of the heroines to enter that region, until their blood was mingled with that of the other victims in the Whitman Massacre, those two brave people gave of themselves lavishly in the upbuilding of America's empire of the Northwest.

What an effective railway promoter Doctor Whitman would have been had he lived 40 years later. And how boundless would have been his satisfaction had he been able to see lines of rails along the wagon trails he helped to blaze and to view the great transformation wrought by this means of transportation within a few decades. Great trains of wagons were still making their toilsome way towards the Pacific Coast on the Oregon Trail when the first western railroad was being run through and into Utah under military protection. The hostile tribes were as real a threat to the builders of the Union Pacific as they were to the emigrants; and every man was, in effect, a soldier. Col. Henry Inman, in *The Great Salt Lake Trail*, had this to say on that subject: "The commissary department was open to us. Their troops guarded us and we reconnoitered, surveyed, located and built inside their picket lines. We marched to work by the tap of the drum with our men armed. They stacked their arms on the dump and were ready at a moment's warning to fall in and fight for their territory."

When this truly American railway had reached a point where it formed a junction with the Central Pacific at Promontory Point, consummating Lincoln's dream of a railway to the Pacific, colonists in the Northwest began earnestly to hope and to plead for the extension of the line to the Columbia. These hopes were realized in the construction of the roads now known as the Oregon Short Line and the Oregon-Washington Railroad & Navigation Company, completing the great Union Pacific System that has contributed in so large a measure to the development of the Northwest.

In keeping pace with the rapid growth of the country and with the advancing standards of railway transportation, the Union Pacific has made lavish expenditures in improving its facilities. A current example of this investment in better service is the driving of a 556-foot tunnel on the line of the Oregon-Washington Railroad & Navigation Company near The Dalles on the Columbia River. This project was taken in hand for the purpose of bringing about a marked reduction in the curvature of the road; and it involves the excavating of approximately 43,800 cubic yards of basalt rock. The successful



Top—Track-mounted 5½x5-inch Ingersoll-Rand compressor operating air wrenches tightening joint bolts. Center—A 10x8-inch portable supplying air to spike drivers and wrenches. The latter are removing nuts from rails. Bottom—Laying new rail sections by aid of a motor-driven crane.

bidder for this contract was J. F. Shea & Company, which is speeding up operations by the use of N-75 drifters drawing air from an XCB-2 compressor.

The Union Pacific has also recently completed an extensive program of rail-relaying in the vicinity of Portland. This work involved the tearing up of old 90-pound rail and of putting down in place of it 110-pound sections that are more in keeping with the demands of present-day heavy traffic. To do this with all practicable dispatch, the road amplified its maintenance-of-way equipment by the purchase of air-operated tools for the driving of spikes as well as wrenches for the tightening of bolts.

A 5½x5-inch compressor, driven by a gasoline motor and provided with a self-propelled railway mounting, was used to operate two of the new 99-C wrenches that tightened all the joint bolts, while a 10x8-inch unit of similar design supplied air to four CC-250 spike drivers and to a second pair of 99-C wrenches that quickly removed the nuts from the old rail.

The cities on our Pacific Coast are so up to date that their cosmopolitan atmosphere belies their youth. It is difficult to grasp that the Northwest has come about within the memory of a single generation. When one of the present associate chief justices of our Supreme Court, Oliver Wendell Holmes, was a young man, the wagon trains were carrying large emigrations to the Oregon country each year. The slogan "54-40 or fight" was still fresh in the mind of every American. The great Indian wars of the Northwest were brewing. The chiefs were just beginning to realize that the Yankees were becoming entirely too numerous and too ambitious, and that their old freedom and good hunting were on the decline. Very much of the present charm of the North Pacific Coast country is traceable to the prevailing spirit of youth and to its inherent wealth of opportunity.

Sacajawea, the heroine of the Lewis and Clark expedition.

Raising sunken areas of concrete paving by forcing a quick-setting plastic material under the hard top surface. The "Mud-Jack" is shown at the right. Insert—Putting the nozzle of the pressure hose into one of the holes drilled in the pavement.

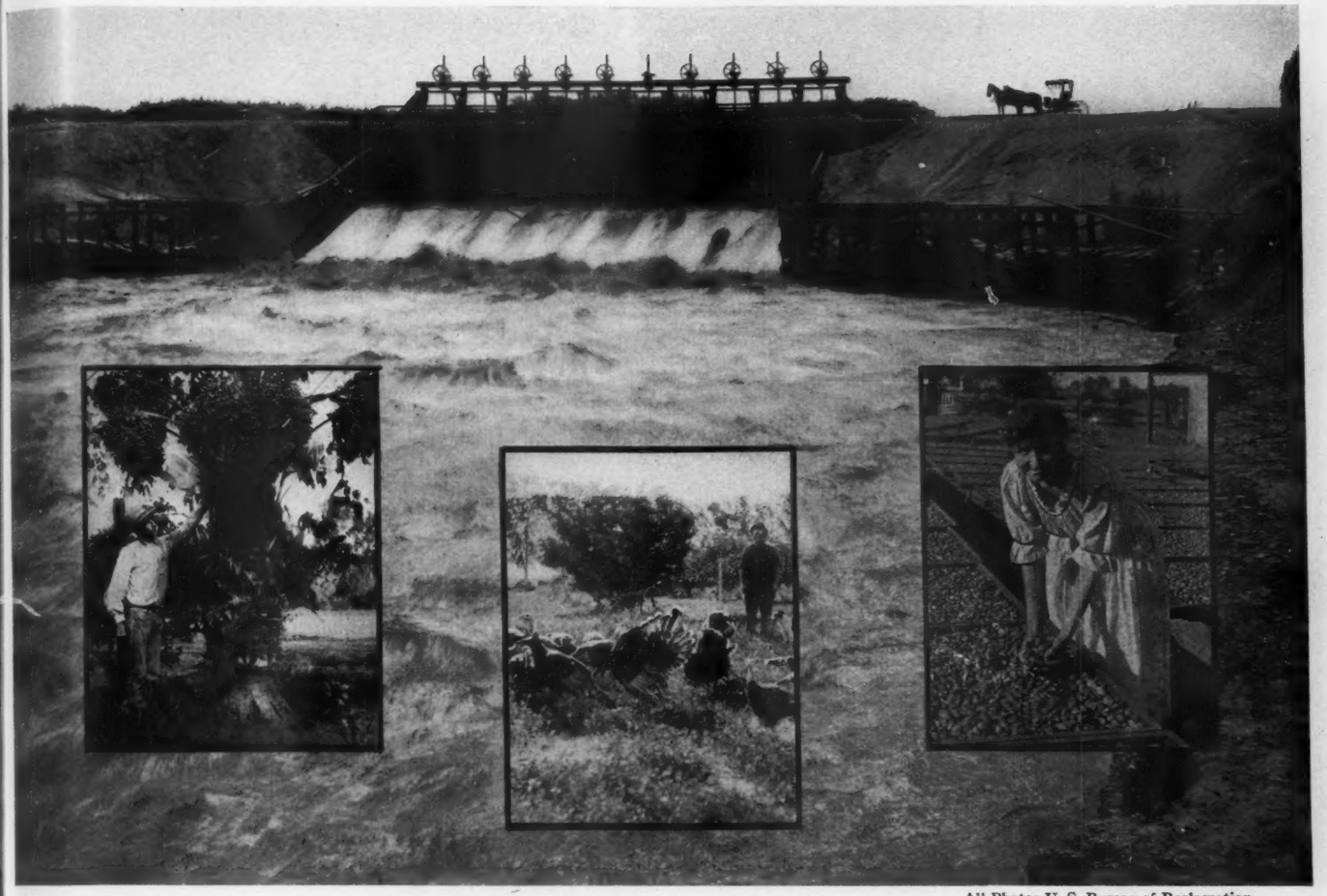
HYDRAULIC METHOD OF RELEVELING SUNKEN PAVING

THE highway departments of some of the states in this country are subjecting certain of the roads that come under their jurisdiction to what might be called face-lifting operations—smoothing out the ridges or uneven places by the use of a machine known as a "Mud-Jack". It is a combination mixer and pump, by means of which any section of a pavement that has settled can be restored to its original grade without tearing up the concrete or other rigid surface.

Working in conjunction with the "Mud-Jack" are two light trucks to haul dirt, a tank wagon to carry water, and a portable compressor equipped with a "Jackhamer", an air drill, and a paving breaker. The latter outfit is required for the preliminary operations—the cutting of two slots, each 4 inches wide, and the drilling of 2½-inch holes in the sunken paving. The slots are cut from opposite sides toward the center of the highway, and preferably along a transverse expansion or construction joint; and they are designed to give freedom of movement to the slab while it is being raised. These "relief openings" are temporarily sealed with clay or other suitable material before the filling-in process is begun so as to prevent leakage. Subsequently they are cleaned out and refilled so as to serve once more as an expansion joint. The number of holes drilled to receive the "mud" or filler depends upon conditions, but three are usually put down for each 8 feet of 18-foot section.

Top soil, cement, and water constitute the mix, which has a consistency close to that of mortar. It is made up of 1 part of cement to 25 parts of earth; and about 100 gallons of water are used for every cubic yard of dry material. This fluid mass is forced from the "Mud-Jack" through a 2½-inch hose, which is successively inserted first in one hole and then in the next until enough has been injected to bodily lift the slab to the level desired. A pressure of 1 pound per square inch is ordinarily more than sufficient to do this, although higher pressures are sometimes required to pry the pavement loose from the subgrade. Depressions of from 1 to 18 inches, it is claimed, have thus been brought back to grade with equal facility.

Iowa is one of the states that has made extensive use of this system of releveling roads. During the summer of 1930 substantially 19,000 square yards of sunken paving was raised there at a cost—including labor, overhead, and rental of equipment—of $1.09 per square yard. The "Mud-Jack" is the product of the National Equipment Corporation of Milwaukee, Wis.



All Photos U. S. Bureau of Reclamation

Sharp's Heading, where water is drawn from the Colorado to irrigate farmlands in the Imperial Valley. Inserts—What irrigation has done to make arid acres abundantly productive.

America's Wonder River---The Colorado

*Something About Its Continually Changing Delta and the Adjacent Arid Region Which It Has Created and Which Man Is Now Making Abundantly Fruitful**

By R. G. SKERRETT

THE Colorado is an anomaly among the great rivers of the world. In addition to certain unique physical features, it has differed radically from other waterways of comparable size because its main stream has generally repelled man's efforts to put it to his use.

The majority of large rivers have lent themselves to utilization in one way or another. They have facilitated exploration; they have aided man in many subsequent practical ways; and, finally, they have stimulated industry and commerce and the development of the contiguous watershed. In well-nigh all these respects the Colorado has stood forth a conspicuous contrast; and after the hundreds of years that the white man has known about the river it still is of service to him in only a small measure of its potential capacity. These facts emphasize the problem now squarely faced in building the Hoover Dam so that the stream can be controlled and utilized in ways that so long seemed impossible.

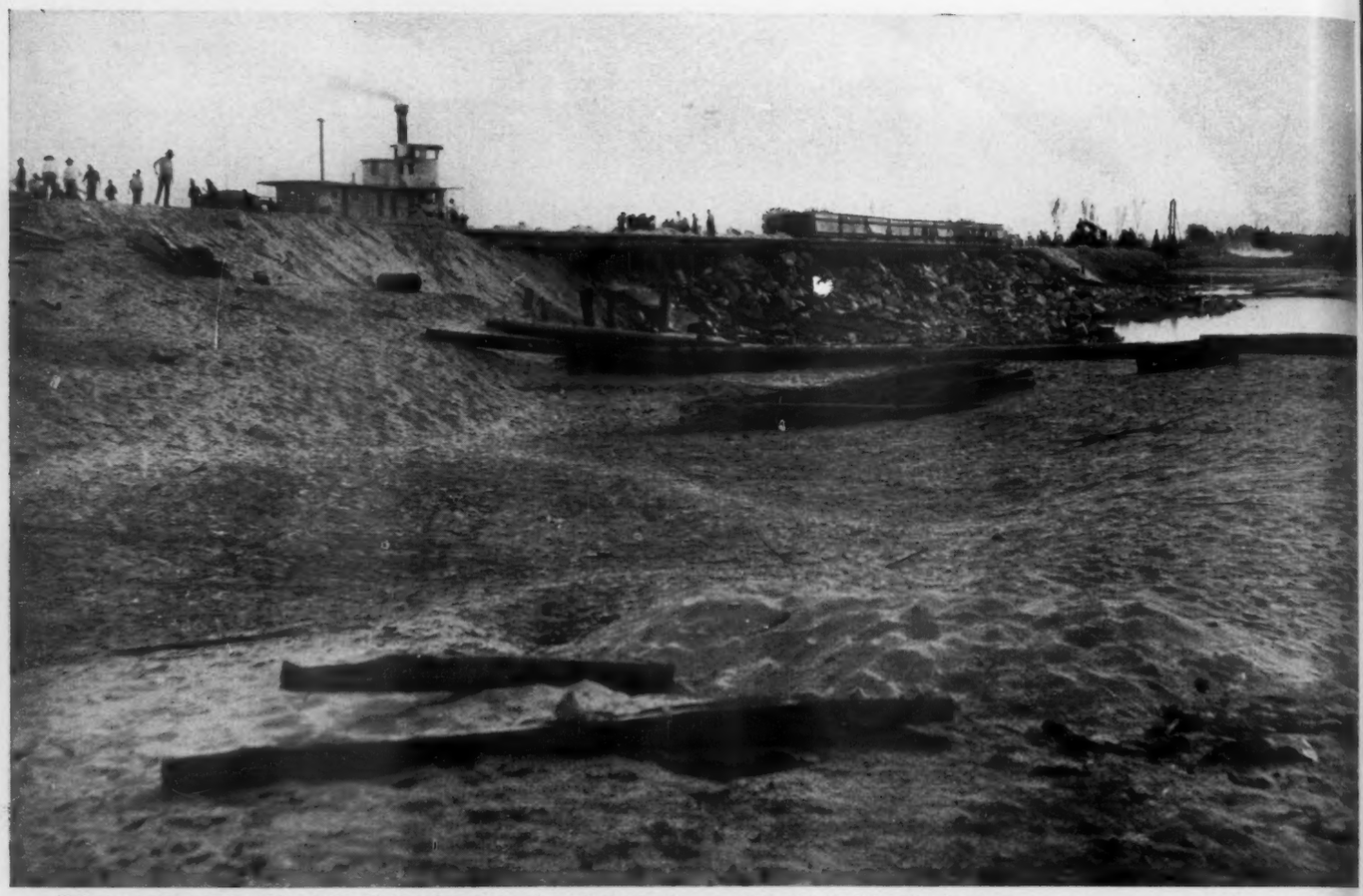
What the Aborigines Did

Cliff dwellers and other early Indian occupants of the territory, drained by some of the Colorado's tributaries, put those rivers to use in irrigating contiguous lands. Those aborigines set the pace in this particular a thousand or more years ago; and in many instances the ditches they dug have survived to the present day. Those Indians were wise: they did not try to tap the main body of the Colorado. They knew from many appalling examples just what the river could do in flood periods when its waters were on their annual rampage. Neither did they venture down into the canyon region with the thought of cultivating and irrigating any arable areas that might be found close to the stream.

On the other hand, the Cocopahs and the Yumas early began the growing of crops on the delta lands adjacent to the mouth of the Colorado; but in doing so they took conditions as they found them from season to season and made no effort to change the ways of the river. Where and when the delta lands in due time emerged from the receding floods, the Indians cast their seed, without tilling, upon the wet mud. The method, of course, was primitive like the people, but even so the Indians were able to raise substantial crops of beans and maize and squashes by reason of the fertility of the saturated silt and the wealth of sunshine which shone upon the region. Those aborigines did not know it, but they were doing exactly what the *fellahin* of Egypt had been doing since the days of the Pharaohs each year as the flood waters of the Nile went their way seaward and left vast sodden areas exposed for planting. It might here be mentioned that the delta of the Colorado and the delta of the Nile are much alike climatically—both are subtropical.

The comparison between the two rivers is a limited one. The rise and the fall of the waters of the Nile, as recorded for nearly 5,000 years, is remarkably uniform both in

*Second of a series of articles on the Colorado River and the building of Hoover Dam.

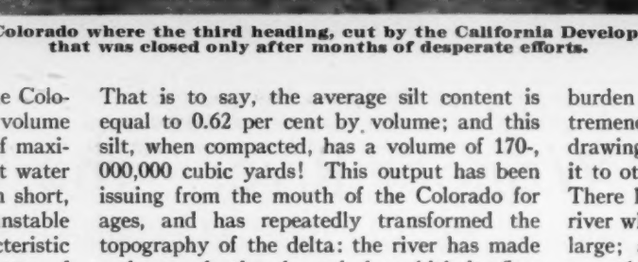


Point on the west bank of the Colorado where the third heading, cut by the California Development Company, caused a break that was closed only after months of desperate efforts.

degree and in time of occurrence. The Colorado, however, varies widely in the volume of water carried by it at the period of maximum flow; and the time of its highest water cannot be foretold with certainty. In short, the river is in a continual state of unstable equilibrium. In the past this characteristic made farming for the Indians a matter of considerable speculation both as to when they could sow their seed and where it would be possible for them to do so. The Indians at least proved conclusively that the delta lands of the Colorado were extremely fertile.

Before we tell how the modern farmer has undertaken to develop lands formed by the Colorado more or less in the neighborhood of its present mouth, let us see how those productive lands came into being and long constituted a veritable desert region until an imaginative white man envisioned their potential agricultural value. The story of their creation is one more evidence of the unstable nature of the Colorado River.

The Colorado carries toward the sea each year an enormous amount of solid matter in suspension; and measurements made with much care over a span of years have revealed that the silt content of the stream at Yuma amounts every twelvemonth to substantially 105,000 acre-feet. That is to say, the average silt content is equal to 0.62 per cent by volume; and this silt, when compacted, has a volume of 170-, 000,000 cubic yards! This output has been issuing from the mouth of the Colorado for ages, and has repeatedly transformed the topography of the delta: the river has made and unmade the channels by which its flow has reached the open waters of the Gulf of California. This is understandable, because the silt-formed land or river bed offers only a trifling opposition to the erosive action of the stream—a thin thread of water soon becoming a sizable one and, in its turn, growing rapidly to the proportions of a rampant river. The Colorado, when carrying its greatest burden of solid matter, may be likened to a tremendous hydraulic dredge engaged in drawing up silt at one point to distribute it to other points for the upbuilding of land. There have been times in the history of the river when the alluvial flow was exceptionally large; and on those occasions the stream wrought the most pronounced changes in its delta. Remember that the average yearly discharge of silt is equivalent in volume to all the earth removed in digging the Panama Canal! At some period in its history—prior to the traditions of the Indians in that part of the continent, the Colorado probably emptied directly into the Gulf of California not far below Yuma of today. When that was the case, the Gulf of California extended nearly 150 miles north of its present northernmost limits, and the Colorado discharged into the gulf something like 100 miles south of the head of that body of water.



Southern Pacific Railway bridge at Yuma, in 1916, when the flood was at its height and had a velocity of 240,000 second-feet.

Genesis of Imperial Valley

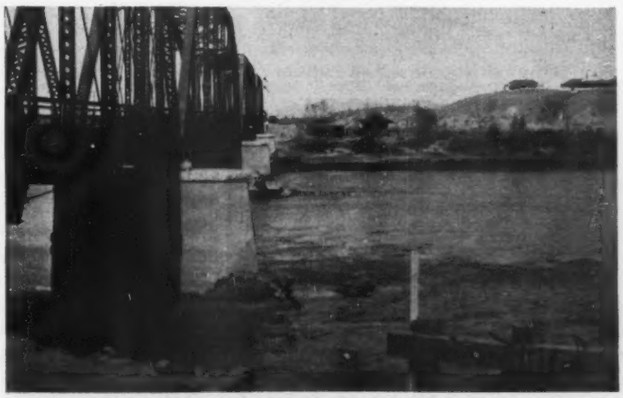
Year by year, the Colorado built up a fan-shaped delta that widened and lengthened as the river spread out its burden of silt upon the bed of the gulf. Eventually—probably initiated by some season of unusually heavy alluvial outpouring, it started the growth of a jetty of mud on

Striking evidence of the havoc wrought by the Colorado River when inundating the Imperial Valley. The banks cut by the water range from 30 to 40 feet in height.

its western flank and southward from its mouth. Gradually this jetty grew until it became in effect a broad, low dike across the gulf, and thus cut off and isolated the area of which the Imperial Valley forms a part. In the course of centuries the impounded water evaporated, until only a remnant of the erstwhile volume remained in the deepest section commonly known as the Salton Sink or Salton Sea. The whole isolated area slopes from the river toward the sink, which lies 278 feet below the normal surface of the Pacific.

While building up the barrier just mentioned the river, incidentally, elevated its own bed by successive deposits of silt. Today, the Colorado flows through a delta which, in some sections, is 100 feet above the sea. During flood periods, the river may wander in one direction or another by reason of this elevation and the character and conformation of the delta. In brief, it is likely now as it has been in the past to spill over its banks anywhere during seasonal high water. When the river does this, it piles mud upon its banks and tends to raise the entire flooded area by new deposits of silt.

Conversely, as the flood waters diminish and drop, the Colorado commonly returns to the channels just previously used by it—the receding waters closing the outlets made during the flood by deposits of mud. On the other hand, the river may continue to follow a new channel cut during the high-water period; and numerous ancient channels give visible evidence of how diverse have been the routes used by the stream in the past to reach the sea. For a long while, in historic time, the Colorado kept generally to a well-defined main channel leading nearly southward into the Gulf of California; but even so it occasionally broke through the dike, of its own building, which has separated it for centuries from the vast basin which used to be the head of the Gulf of California. This excess water has uniformly flowed northward toward the Salton Sink. These digressions were of little concern to man until steps were taken to develop the Imperial Valley for agricultural purposes—then the inundations became menaces to life and property.



The same bridge after the Colorado had returned to normal. The river then had a maximum flow of but 20,000 second-feet.

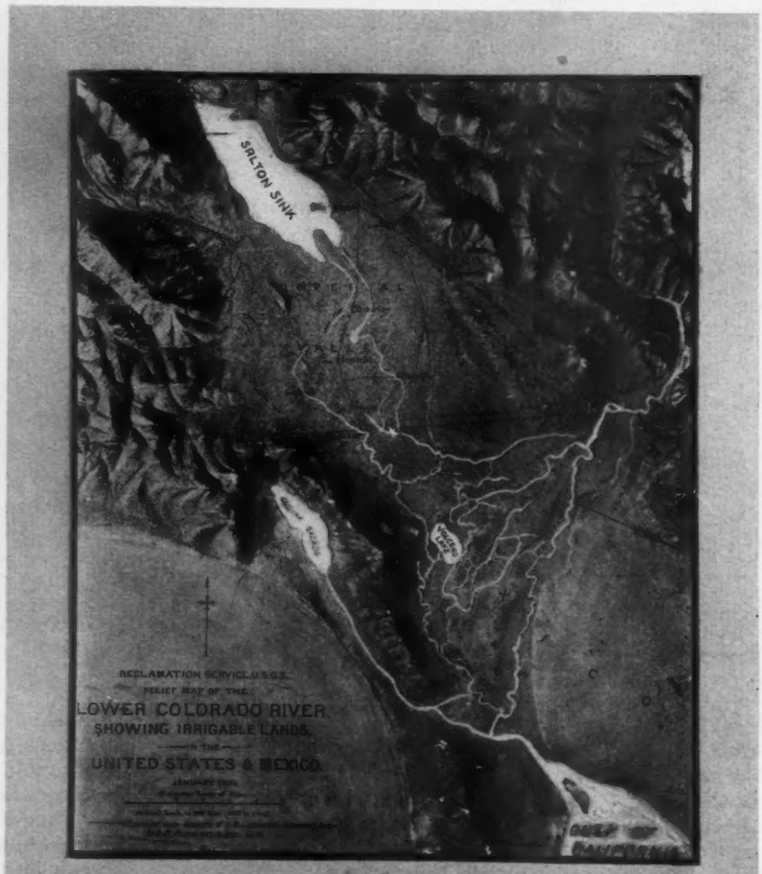
Man Settles in the Valley

We need not ponder the questionable wisdom of those adventurous persons who early urged that the Imperial Valley could be turned into a vast farm if water could be distributed to its arid but fertile soil by tapping the Colorado River. Dr. Oliver M. Wozencraft may properly be called the pioneer in this movement, because he urged such a project after he had crossed the desert lands of the Salton Sink in 1849. Even so, it was not until the spring of 1900 that the scheme took final shape when a contract was awarded for the digging of a canal that would link the Colorado River with the dry bed of what has become known as the Alamo River—the latter taking the water delivered to it by the Imperial Canal and leading the vitalizing flood northward for distribution in the Imperial Valley. That epochal work was done

by George Chaffee; and in less than two years fully 400 miles of main canals and laterals were dug under his energetic direction.

The fertile soil, the water, and the abundant sunshine together wrought wonders after seed were sown; and the amazing agricultural potentialities of the region were quickly established beyond question. The problem that soon became pressing was the security of that ambitious venture, because the participants had put themselves in a depression far below sea level and were drawing water from a river whose unstable course flowed high above the sea level. How long could the people so situated count upon holding the Colorado at bay when that capricious stream was on the rampage?

At the start, the development company led water from the river through headworks, known as Hanlon's Heading, constructed on the west side of the stream just above the international boundary; and shortly afterwards Sharp's Heading was built in Mexico just below the boundary—the idea being that water could be delivered to the Imperial Canal by either heading. Knowledge of the success of the first farmers of the land drew thousands of other settlers to the basin, and this influx led promptly to demands for larger and larger quantities of water. Difficulties had been encountered in keeping the original heading open—mainly because of the rapid accumulation of silt; and the canal operators were forced to cast about for some other means of providing needed water for the cultivated lands. Something had to be done and done quickly; and as the company was hard-pressed for funds, its management resorted to a hazardous expedient.



Top—Relief map of the Imperial Valley, Salton Sink, and a part of the delta formed by the Colorado. The course of the river below Yuma has changed since this map was made in 1905. Bottom—Flood waters converging into a definite channel and forming falls as they cut backward upstream.

Man Tempts the Colorado

Against the advice of competent engineers a third heading was cut in the bank of the river a short distance below Sharp's Heading—this new heading affording a short and quick descent from the Colorado to the Alamo. This was done in October, 1904, and the cut was from 40 to 50 feet in width and ranged from 6 to 8 feet in depth. The excavation was made directly in the mud of the river bank; and that opening permitted a relatively small amount of water to flow into the basin for the immediate relief of the farmers. What followed was thus summed up by F. H. Newell, in 1907, when Director of the United States Reclamation Service:

"The California Development Company did not have approved plans or funds available to build headworks in this opening, and it was assumed that, with ordinary care and watching, the channel could be kept open just sufficient to allow the needed amount of water to pass out from the west bank. With the next rise in the river, however, the fears of the engineers were fulfilled. Following a capricious mood, the river concluded to go down the easy channel toward the Alamo and sent from day to day an ever-increasing flood, rapidly eroding the channel. This continued until, in the spring of 1905, the entire river was passing by an abrupt turn to the westward down the Alamo channel, spreading out over the low ground and ultimately converging toward Volcano Lake or northerly into the New River and the Salton Sea. The old channel of the river, where it formed a part of the international boundary and at points below, soon became completely dry and rapidly assumed the ordinary appearance of the alluvial desert."

The flood waters of the Colorado overflowed the natural bed of the Alamo and spread out across the desert—in some sections the inundation covering the land as far as the eye could see. It was flowing over soil built up either by the sweep of winds or by the river during some of its previous incursions into the basin, and the ground was, therefore, of a character that could be cut away quickly as the flood turned into numerous separate streams which gathered headway as the increasing slope of the basin added to their velocity. These streams scoured out channels in the soft earth which, at points, were quite 1,000 feet in width, a good many feet in depth, and filled with turbulent torrents.

Following a characteristic tendency of streams flowing in yielding ground, the flood waters cut continually backward toward their source, forming deep and steep-sided gulches—the runaway waters leaving the lands that were undamaged remote from the supply of water for their growing crops. But the worst that was apprehended was that these flood streams might continue their back-cutting until they reached the Colorado, and there destroy the remaining headworks and turn the whole volume of the river down into the Salton Sea. It was even feared that the back-cutting might then travel up the Colorado and undermine the Laguna Dam, which was at that time building above Yuma!

When the trouble-making third heading was cut in October, 1904, the surface of the water in Salton Sink stood at 273.5 feet below the mean sea level. By the time the break at that heading was closed in February, 1907, the water in the sink had mounted to a point 201 feet below the sea—that is to say, it rose a total of nearly 73 feet and increased the superficial area of the so-called Salton Sea to 298,240 acres. Had the river not been balked and turned back into its established course, after months and months of desperate work, its

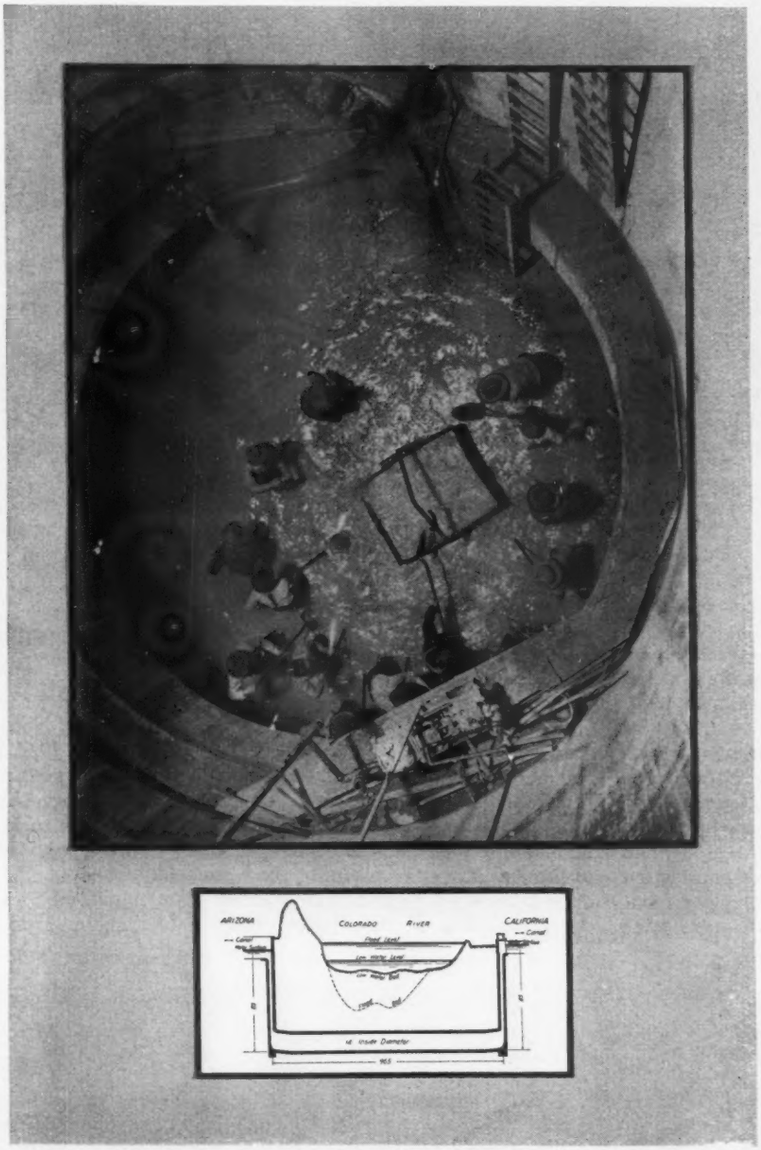
entire flow would have continued to pour into the basin. A simple computation, based upon the annual influx, would disclose how soon the Colorado could reflood the area which it had capriciously isolated in the remote past. At the rate of evaporation normal to the region, centuries would probably pass before the Imperial Valley would again be dry.

Battle to Shut Out the River

During the anxious period between the development of the dangerous break and its closure, those engaged in battling with the river believed more than once that they were engaged in a forlorn hope; but they held on grimly to the task set them. Almost at the instant that the channel was confined to any promising degree, the swift currents began burrowing and undercutting the obstruction of man's making. It is said that piles 70 feet in length were dislodged and swept away as fast as they could be driven into the water bed. Indeed, any narrowing of the channel by the placing of an obstruction merely increased the velocity of the flow and intensified the stream's erosive strength so that it cut enormous gaps in the space of only a few hours.

In the end, the fight was won by the engineering force of the Southern Pacific Railroad whose tracks were several times relocated in anticipation of further flooding of the Salton Sink and who took over the task of saving the Imperial Valley from inundation after the development company proved unequal to it. Again we shall quote from F. H. Newell's absorbing description of the work:

"Added to the unfavorable character of the bed and banks was the fact that the river seldom remained quiet for any considerable length of time. It was subject to short violent floods, especially from its tributary, the Gila. These, occurring at a time when the work was in a critical condition, quickly rendered useless the efforts of the constructors. The method finally adopted for turning the stream was one whose success depended upon having at hand a large railroad equipment and an enormous amount of material which could be quickly transported. ..... The chief difficulty was to secure a sufficient supply of stone fast enough to fill the gaps as they were washed out. In some cases trains of flat cars loaded with stone were brought from a distance of 400 miles. ..... As the rock heap rose gradually it checked the river, causing it also to rise higher and higher and to cascade over the pile of stone. Riffles were caused, and an undercutting of the lower slope, or of the rock heap, allowed it to settle and the stones to roll downstream. All of this undercutting and settling had to be made up and overcome by the rapid dumping of other large stones. It was necessary to raise the river bodily about 11 feet. As the water rose and became ponded on the upper side of the rock heap, trainload after trainload of small stone and gravel from the nearby hills was dumped to fill the spaces between the large rocks." When hydraulicked with silt and covered with earth and gravel, the dike became effective against seepage. The breach was closed and the river forced back into its channel in February of 1907—that victory costing about $2,000,000.



Top—Looking down the Arizona shaft of the Colorado River siphon. Bottom—Cross section of the siphon. Note the depth to which the river scores its bed during a flood period and upbuilds it again with silt as the waters drop and resume their normal quieter flow.

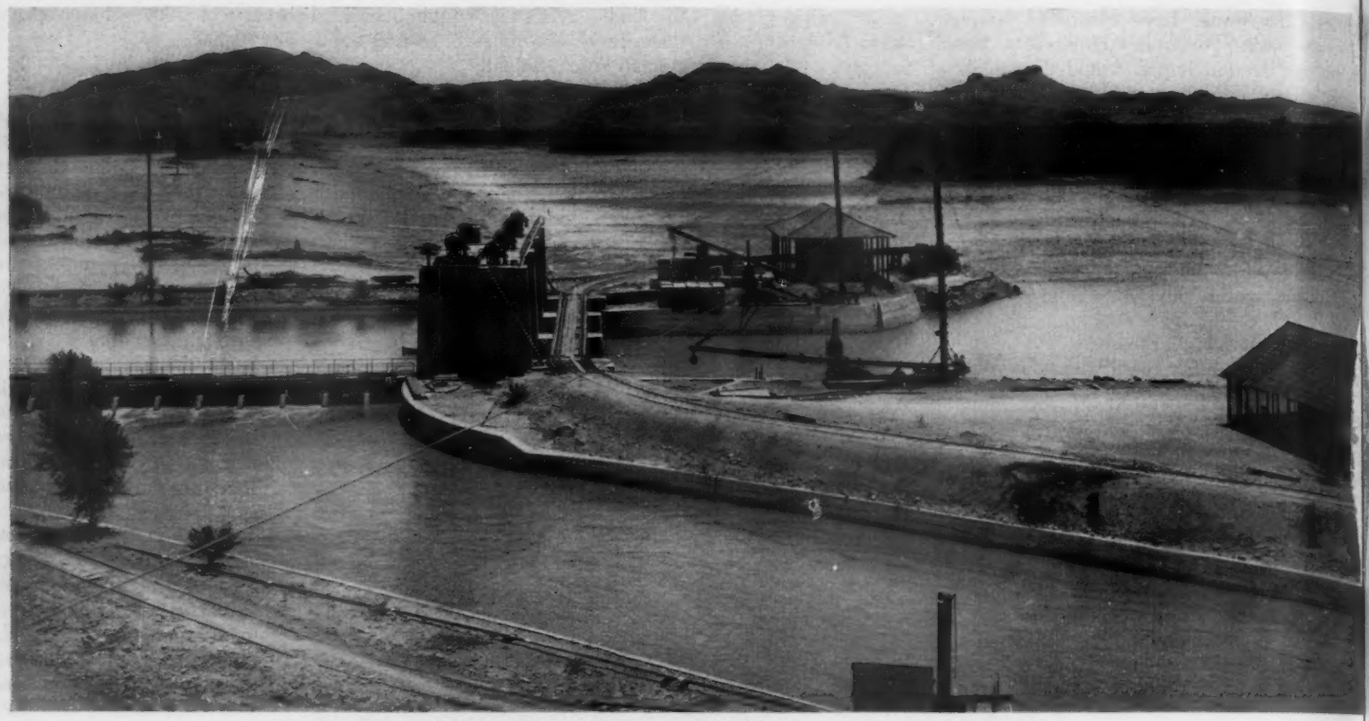
River Renews the Fight

The Colorado was merely halted but not whipped. Raising its bed with deposits of silt at the rate of something like 10 feet annually, it was ready for another offensive in 1909; and the point of its attack then was only a short distance below where it had breached the defense of the Imperial basin in 1905. The river forced its way through the dike 29 miles below Yuma, and turned its flood westward through Bee River into Volcano Lake—hastily built levees sufficing to keep the stream from reaching the Alamo and the New River drainage basins. After pouring an enormous amount of silt into Volcano Lake, the Colorado carried its flood waters to the channels offered by the Hardy and the Pescadero rivers and thence onward to the Gulf of California. The rapidity with which the Colorado silted Volcano Lake made the task of rearing a levee there a desperately difficult one. However, the engineers were able to upbuild the dike fast enough to keep the crest above the rising water. Two years later the Federal Government appropriated $1,000,000 to relieve the menace at that point.

To date, approximately $7,000,000 has been expended in efforts to protect the Imperial Valley from inundating floods; and the silt carried into the irrigating channels presents a continual problem. The deposits must either be dredged out, to keep the channels at a given level, or dikes must be continually raised to prevent the water from overrunning the lands as the silt shallows the irrigating arteries. It is said that the disposal of silt in the Imperial Valley entails upon the district a yearly outlay of $1,400,000.

Man's Success in the Valley

What has been told about the origin of the Imperial Valley and the uncertainties attending the Colorado when on a flood-period rampage should make reasonably clear the menace to which dwellers in the basin are continually exposed as long as there is no flood control of the river. Since the first farms were irrigated in that desert region, about 29



Laguna Dam and sluice gates viewed from the California side of the Colorado.

years ago, something like 500,000 acres have been brought under cultivation. Numerous towns and lesser communities have come into being; and the population of the valley at the present time probably exceeds 75,000 persons.

As might be expected, the summers are hot and the winters are mild. In the Imperial Valley the principal crops are lettuce, peas, spinach, and other vegetables; and a large acreage is given over to the growing of cantaloupes, grapes, strawberries, and citrus fruits. Because of the warmth of the climate, farmers in the Imperial Valley can produce these commodities at a very early season; and quantities are shipped to northern and eastern markets. That is to say, the foregoing foodstuffs are not generally obtainable at the same time of the year in other sections of the United States. The value of the crops produced annually in the Imperial Valley is close to $100,000,000.

Manifestly, there are substantial economic reasons for protecting this fruitful area which has been brought to its present status by settlers of great courage and abounding determination to win success in the face of grave natural odds. As matters stand now, the river may at any flood time break from its shifting and uncertain channel and turn its full volume into the Imperial Valley; and such an occurrence could not be likened to the inundating of other regions that would soon emerge from the flood waters. Should the Colorado break into the valley, and no means prove effective in an effort to turn the river back into its accustomed channel, then the influx would produce a permanent inundation because there would be no outlet for the imprisoned flood.

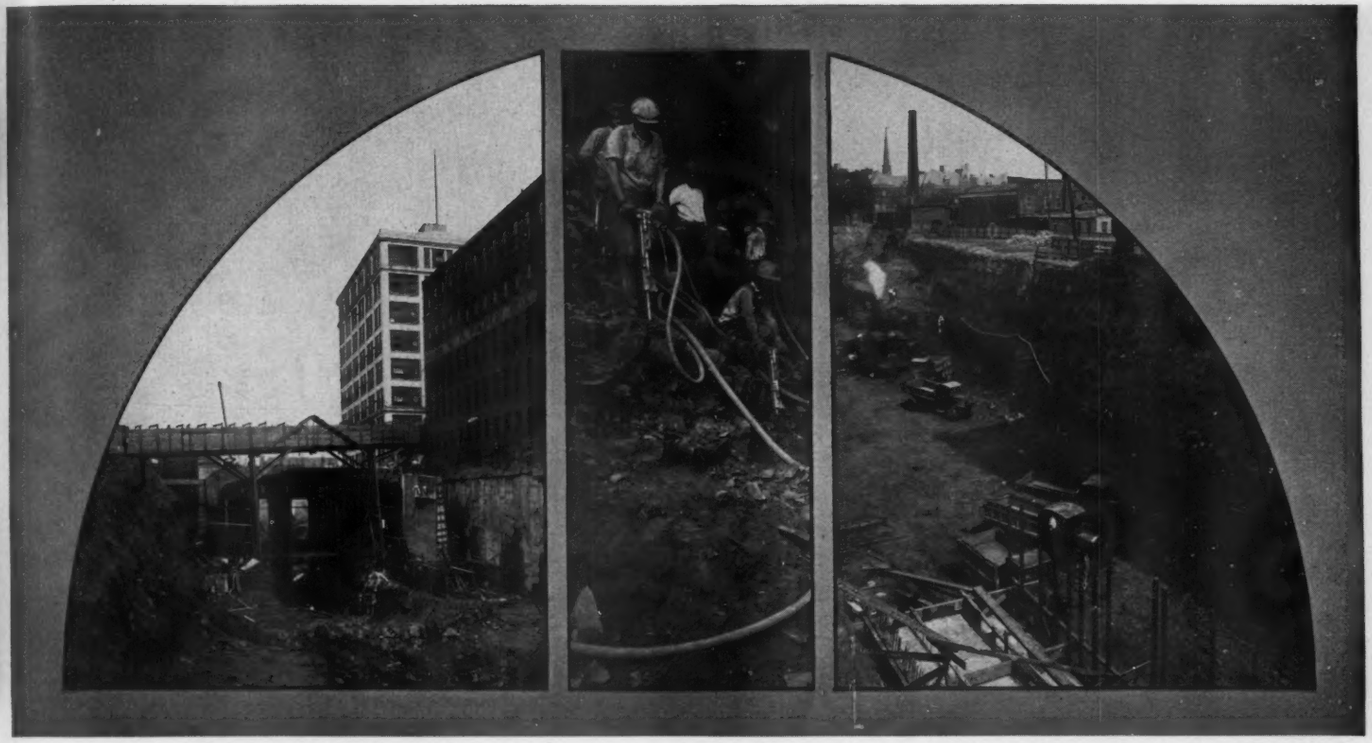
In lesser degrees, reclamation projects at Palo Verde, on the California side of the river, and at Yuma, on the Arizona side, will be beneficially affected by any control of the flood waters of the Colorado; and it should be manifest that the well-being and security of life and property on any of these regional undertakings will hinge to a large extent upon the completion of the Hoover Dam. In short, the builders of the Hoover Dam are racing against time and the uncertain moods of America's wonder river.

Boats were the only means of traversing Main Street in Yuma when the 1916 flood was at its height.

MERSEY VEHICULAR TUNNEL NEARING COMPLETION

THE vehicular tunnel under the Mersey at Liverpool, which was started in December of 1925, is to be officially opened to traffic about a year hence, provided the present rate of progess is maintained. About 1,000,000 tons of rock have been excavated; 30,000,000 tons of water pumped out; and 240 tons of explosives, 76,000 tons of cast-iron lining, and 263,000 tons of concrete used. Only 5,000 cubic yards of rock now stand between the workers and the completion of the under-river section. Approximately 930 men are at present employed on the undertaking.

The plans call for a ventilating system that will force 4,000,000 cubic feet of fresh air a minute through the tube, which will have a length of 2.93 miles. Under normal traffic conditions the tunnel will accommodate 3,000 automobiles an hour; and a total of 2,000,000 cars are expected to pass through it annually. The project is being built at a cost of more than $24,000,000.



Left—Where the subway underruns High Street, Newark. Center—Paving breakers and "Jackhammers" excavating rock in open cut at High Street. Right—Open cut in bed of old Morris Canal west of High Street.

Bed of Old Canal to Serve as Subway Route

Newark Is Transforming Abandoned Morris Canal into a Rapid-Transit Subway

By ROBERT S. GREGG

PUTTING new wine in old bottles may be unwise according to tradition. Turning the bed of an obsolete canal into a rapid-transit route, however, has the sanction of modern engineers, paradoxical as the adaptation may seem at first glance. This is exactly what is now underway in that thoroughly up-and-doing City of Newark, N. J.

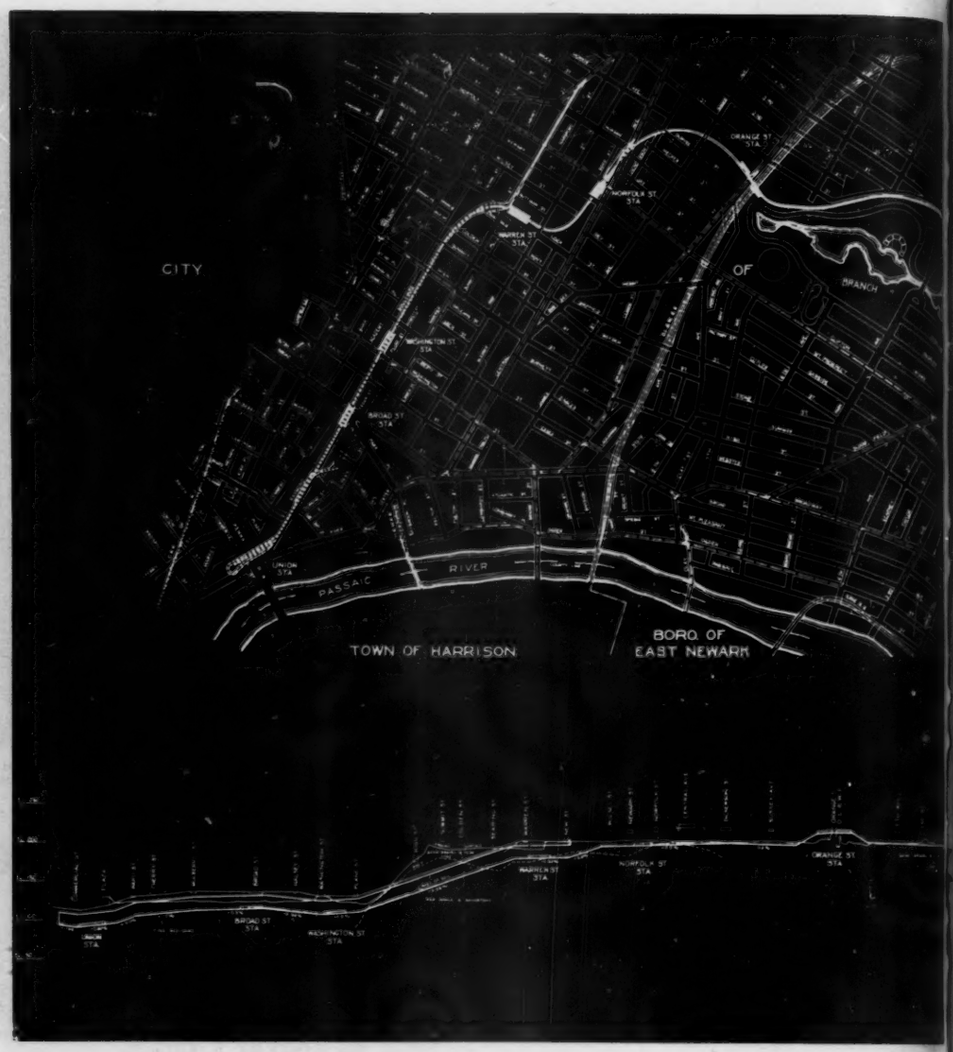
To the average mind a canal exemplifies leisureliness in transportation. One instinctively pictures the boats traveling the sheltered waterway at the walking pace of tugging mules or horses—time counting only in a remotely comparative way. On the other hand, a rapid-transit line inseparably implies speed and an effort to clip minutes in shortening a run between any two points. How, then, is a section of New Jersey's historic Morris Canal being transformed so that it will serve a purpose never dreamed of by those pioneers that brought it into being—men of vision as they were? Before we answer this question let us outline briefly the origin and the service rendered by this ambitious water route when it was at its operating peak.

The Morris Canal had its inception in 1822, when the idea was offered to interested citizens of northern New Jersey who realized that that section of the state was sorely in need of better means of moving its products from mines, forges, furnaces, and farms to places of consumption. As a consequence of well-directed agitation, that went hand in hand with surveys and investigations, public enthusiasm reached a point that warranted the Legislature in passing an act on December 31, 1824, authorizing the incorporation of a company "to form an artificial navigation between the Passaic and Delaware rivers". Ephraim Beach, a well-known canal engineer, was employed as engineer on the project; and Prof. James Renwick, at the time professor of natural and experimental philosophy at Columbia University, New York, was retained as consultant. Thanks to Professor Renwick's inventive genius, inclined planes were designed to take the place of locks at points where the change of elevation was notably abrupt; and the same expert devised the unique reaction turbines that furnished the motive power to pull the canal boats up the inclined planes.

In the first half of 1825 the sale of stock brought in sufficient money to warrant the start of actual construction; and before the end of September of that year there were 30 miles of the canal under contract and a force of 700 men was at work. This force was increased later. Section by section the canal was dug; dams were reared to impound needful water; locks were constructed; and inclined planes were built wherever marine railways instead of locks were to shift craft from one water level to another. Enthusiasm prevailed; and the undertaking went forward at a rapid rate, gaged by standards of the period.

Before the close of 1828 there remained to be excavated between Newark and Phillipsburg only fourteen miles of the projected canal. In December of that year a test was made of the inclined plane built at Boonton, and a boat was transferred from the lower to the higher level in a period of fourteen minutes—the ascent being 80 feet. Government engineers had previously estimated that to effect this shift by means of locks would require 150 minutes. In 1831 the canal was 90 miles long; and a trip from Newark to Phillipsburg could be made in five days. The carrying charge on coal through to tidewater was about $2.25 a ton.

The canal was subsequently extended from Newark to Jersey City—a distance of 11¾ miles, and was ready for service in 1836. The undertaking justified itself during the country-wide period of prosperity in 1836; and with the widening of the planes and the enlargement of the locks the Morris Canal &



Left—Covered section of old canal on Raymond Street, east of Broad Street. Center—Plan of new subway route from projected Newark's busies

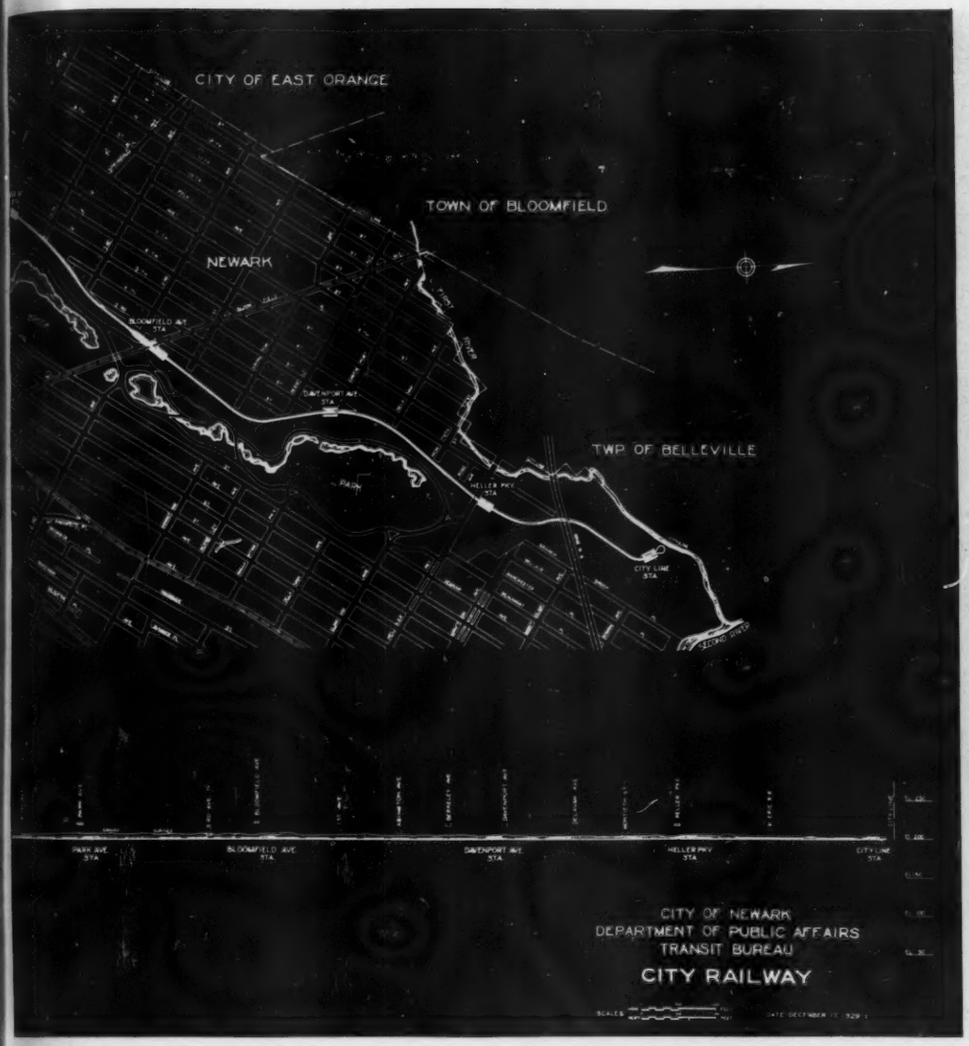
Banking Company began to reap a return on its venture. In those days the president received a salary of $1,600, and the chief engineer was paid $2,000 annually. With the improved planes and locks it was possible to use larger boats carrying cargoes of 70 tons; and business on the waterway boomed. The tonnage on the canal increased steadily from 58,259 tons in 1845 to 889,220 tons in 1866. The latter year marked the peak in business on the canal, and was never again equaled. That twelvemonth the gross income was $616,350.

By the close of 1860 the canal represented a total outlay of $5,100,000; and at that time the route contained 28 locks and 23 inclined planes. In crossing the state, a boat moved vertically 2,134 feet and traveled horizontally a distance of 102.15 miles—a round trip taking ten days. According to the final report made in 1929 by the Morris Canal & Banking Company as trustee for the State of New Jersey: "The decade from 1860 to 1870 was the only prosperous period in the history of the canal. Part of this was due to the general activity of the Civil War period and part to the growth of the territory served. The coal trade was booming. Pennsylvania had sold the Delaware Division Canal to private interests which were favorable to the Morris Canal. .... This enabled the Morris Canal to obtain a greater proportion of the coal carrying trade than had before been possible. The iron works at Boonton and Dover and at other points along the canal were flourishing and supplied considerable business in coal, iron ore, and manufactured iron. All of the towns along the canal had increased greatly in population and were prospering."

Further, from the same report we learn: "Even as the Morris Canal was enjoying its greatest year, in 1866, the end was in sight. For, in this year, the Morris & Essex Railroad, which had been extended to Phillipsburg in 1861, began carrying coal in competition. In 1868 this railroad was leased to the Delaware, Lackawanna & Western Railroad Company, and the competition became serious. This was a death blow to the canal, as it was competition that eventually made it impossible to operate the canal". The canal was never subsequently operated at a profit, although the Lehigh Valley Railroad Company leased the waterway and tried to make it a paying proposition. Thus began the decadence of an undertaking that attracted world-wide interest in its heyday because of the engineering skill that had made it practicable.

It is the section of the Morris Canal lying within the city limits of Newark that is now in process of being transformed into a subway for rapid transit. From end to end this modern electric line will have a length of a trifle more than 4½ miles. The route followed is a sinuous one that adheres in a general way to a rectilinear base formed by a gigantic letter "L" with its upright member tipped to the north and east. It extends from a point on the city line adjacent to the Township of Belleville to a loop, close to the shore of the Passaic River, that will be constructed beneath the new Union Station of the Pennsylvania Railroad shortly to be taken in hand.

The rapid-transit subway consists of four sections upon three of which—embracing the line from Washington Street northward to the terminal adjacent to Belleville—the work is more or less advanced. The central one of these three sections is virtually finished; the northern and longest section has been graded; and the southern section has been run through a densely built-up part of



Public Service Corporation of New Jersey

terminal of Pennsylvania Railroad to the city line contiguous to Belleville. Right—Bed of old canal a little west of Broad Street, thoroughfare.

the city near the business and shopping district. It is with this division of the route that we shall deal presently. The entire project is the result of a three-cornered contract signed January 9, 1929, and entered into by the Municipal Government, the Public Service Coördinated Transport, and the Pennsylvania Railroad Company. The city will build and equip the subway; the Public Service will operate it—providing the rolling stock, leasing the line for 50 years, and paying annually a rental of $125,000 plus 5 per cent of the gross receipts; and the Pennsylvania Railroad will erect a large and thoroughly up-to-date union passenger terminal which will stand above the loop at the southeastern end of the rapid-transit route. The railroad is interested in thus providing facilities for the arrival and dispatch of passengers drawn from or bound to all parts of Newark and that city's contiguous suburbs. The estimated cost of the subway as first planned and as now underway is $6,000,000.

The new Pennsylvania Station will be close to the existing one, which has become inadequate; and it will be near the focal center of Newark's business activities. It is from that point that many of the surface railways radiate more or less like the spokes of a wheel: and it is easy to understand how congested have become the thoroughfares of this thriving and bustling municipality of more than 442,000 people. The purpose of the subway is to reduce congestion in a measure by diverting certain of the trolley lines into it before they reach the zone of intense traffic, and, incidentally, to shorten the time of transit of persons bound into or from this area. It is authoritatively stated that the new transportation system will make it feasible for passengers using facilities tributary to the subway thus to save from ten to twenty minutes. Four existing trunk-line trolley routes will use the new right of way.

The subway will have two tracks; and in adapting the course of the Morris Canal it has been necessary to widen and to deepen the original excavation. This has entailed the demolition of some flanking structures and the very careful underpinning of a good many others. The contractors have also been obliged to hinder as little as possible traffic on highways crossing the route. All work is required to be done in a manner calculated to promote rapidity in construction, to safeguard life and property, and to reduce to a minimum any interference with abutting property and public utilities. In other words, it has been necessary for the contractors at all times to exercise prudence and skill in carrying their respective tasks forward.

Section No. 3 was awarded the Thomas Crimmins Contracting Company at a contract price of $1,763,284.20. It extends north and west from a point on the Morris Canal near the south building line of Washington Street to a point about 90 feet south of the south building line of New Street and near what will be known as the Warren Street Station. The contract entailed the open-cut excavating of 93,000 cubic yards of earth and 70,000 cubic yards of rock. Among other things, it called for the placing of 36,000 cubic yards of concrete and 2,050 tons of structural steel. This section is about 3,200 feet in length.

The rock encountered by the Thomas Crimmins Contracting Company was what is locally known as New Jersey Triassic red shale and sandstone. According to the contract: "The character of the rock is such as to require the utmost care when excavation is made adjacent to structures, and the contractor shall use such methods of construc-

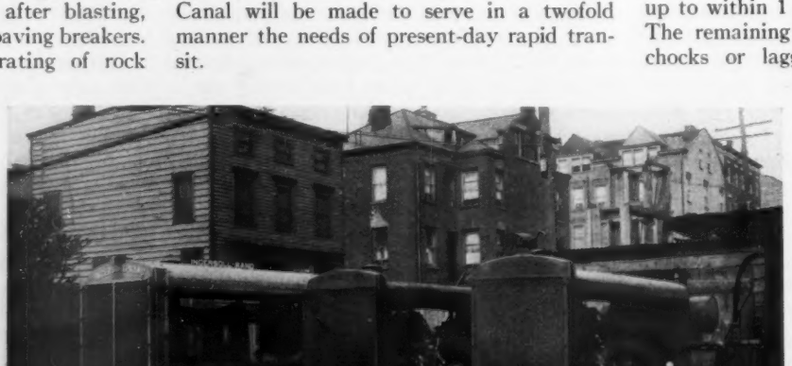
Public Service Corporation of New Jersey

Midday view of Broad Street, Newark, from a point just below Market Street, another much used thoroughfare.

tion as will not impair the stability of these structures, whether underpinned or not." As a matter of fact, the work entailed extensive underpinning with concrete at some points; and necessitated getting out the rock at all times by the use of small charges of explosives in combination with very closely spaced drill holes.

Owing to the character of the rock, it was soon found that the bits had to be provided with side holes to facilitate blowing and to prevent the sticking of drill steels. The work was successfully done with blower types of S-49 rock drills using 1-inch hexagonal steel. For trimming rock surfaces, after blasting, the contractor utilized CA-35 paving breakers. Compressed air for the operating of rock drills and paving breakers was furnished by three 10x8-inch Type 20 portables and one Type XL portable providing a total of 1,550 cubic feet of air per minute. The air was distributed by a main line, consisting of 3-inch rubber hose, delivering to headers equipped with connections for the smaller hose required by the pneumatic tools. The blacksmith shop, which conditioned the steels used on the job, was equipped with a No. 26 oil furnace, a No. 50 sharpener, and a No. 8 pedestal grinder—all of them Ingersoll-Rand products.

According to the existing schedule, the subway will be ready for service when the new Union Station of the Pennsylvania Railroad is finished early in 1934. The line will have a total length of 23,835 feet, and 6,615 feet of it will be covered. As a matter of fact, plans have been prepared contemplating the roofing over of Section No. 3 so as to create Raymond Boulevard, a fine thoroughfare, above it—adding thereby just that much more to the relief of vehicular congestion. If this be done, then the total cost of the subway and the highway will be approximately $10,000,000. Thus the course traced by the old Morris Canal will be made to serve in a twofold manner the needs of present-day rapid transit.

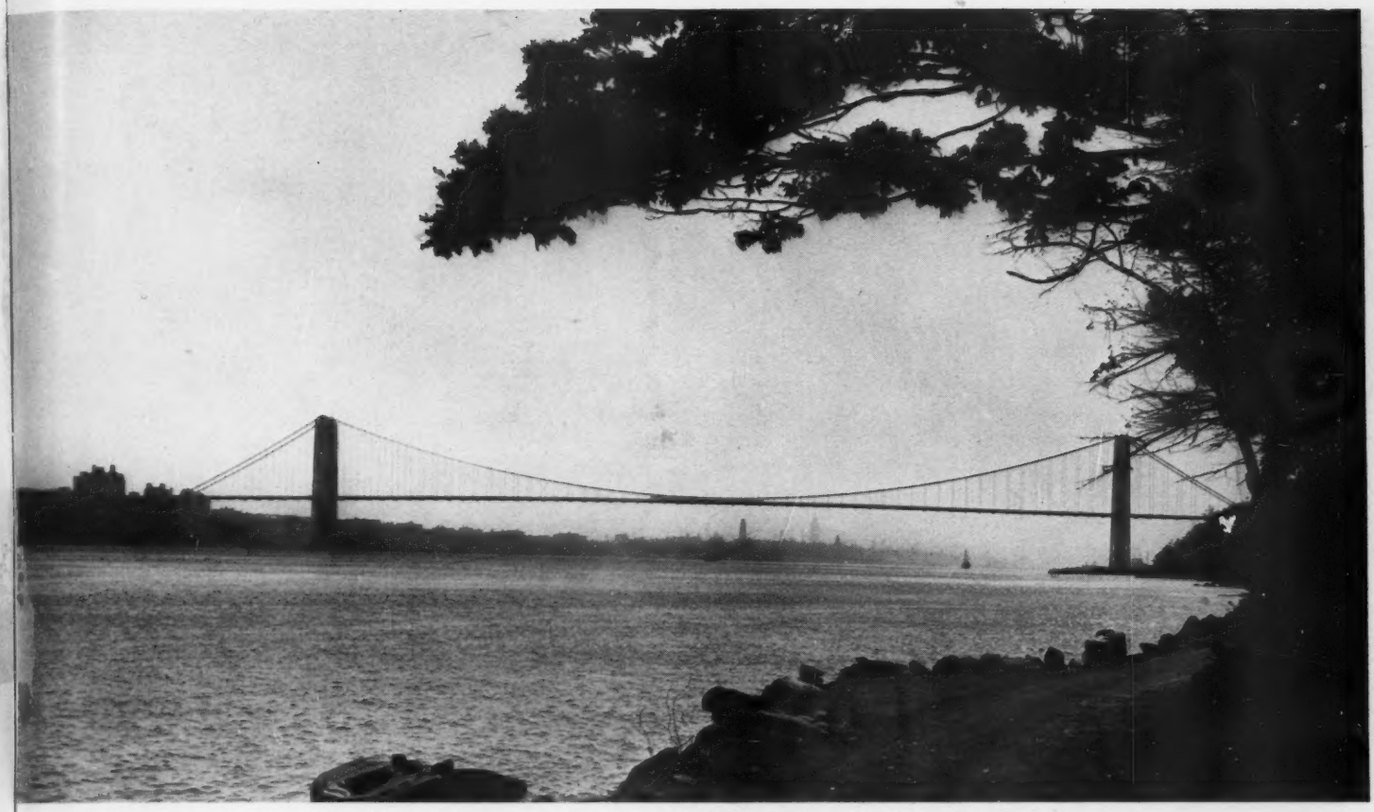


Battery of one 13½&8x10-Inch Type XL and two 10x8-Inch Type 20 portables that furnished most of the compressed air for the contract of the Thomas Crimmins Contracting Company.

BUILT-UP CONCRETE DISKS USED ON RAND FOR WALL SUPPORT

AMONG the practices established of late years in the gold mines on the Witwatersrand is that of using flat concrete disks, familiarly called "pancakes", to support the hanging wall. The slabs are about 30 inches in diameter and 4 inches or more thick; have a 4-inch hole in the center to facilitate transportation; weigh up to 250 pounds apiece; and are reinforced with strands of wire rope. They are quickly put in position once their concrete foundation is laid, and are built up to within 1 or 2 feet of the hanging wall. The remaining space is filled in with small chocks or lagging tightly wedged against the hanging wall.

On flat dips the disks offer enough frictional resistance so as to prevent shifting: on steeper slopes a thin layer of cement or dry sand is interposed. In the New State Area, where they have been used in conjunction with 10-foot pillars for three years, work in the stopes has been interrupted just once because of falls or movement of the hanging wall, and then only for a week along a 100-foot face. During that period 840,000 square feet were stoped.



The bridge as it appears today looking downstream from the New Jersey shore.

George Washington Bridge Now in Service

THE George Washington Bridge is an accomplished fact. With appropriate ceremonies it was opened to traffic on October 24—substantially eight months in advance of the schedule planned when work was started on the gigantic structure in May, 1927. Furthermore, this monster viaduct across the Hudson River was built at a cost considerably below that set by the original estimates.

As is generally known, the George Washington Bridge links the states of New Jersey and New York: the western terminal is at Fort Lee, and the eastern terminal is contiguous to Fort Washington on the New York City side of the river between 178th and 179th streets. The bridge has appropriately been described as a test of engineering skill; and from start to finish the experts responsible for the design and its execution have met every requirement fully. Likewise, the several contractors accountable for different phases of this vast undertaking have in every particular met the very exacting specifications under which they have had to work.

While it is true that the bridge does not differ in principle and in most of its structural features from other outstanding modern bridges, still it does differ notably because of the scale upon which it has been carried out. It is the largest structure of its kind built to date. The designers planned not only for immediate needs but for demands that may be made upon it in the course of the next few years. In order that the magnitude of the bridge can be realized, the principal data are given in the following table:

Length of main span	3,500 ft.
Length between anchorages	4,760 ft.
Width of main structure, over all	120 ft.
Height of towers above water	635 ft.
Number of cables	4
Diameter of each cable	36 in.
Number of wires in each cable	26,474
Diameter of each wire	0.196 in.
Specified strength of wire, minimum, lbs. per sq. in	220,000
Weight of cable wire	28,450 tons
Decks	2
Vehicular traffic lanes	8
Height of roadway above river	250 ft.
Clearance beneath lower deck at center	213 ft.
Steelwork—Silicon steel in towers	23,600 tons
Carbon steel in towers	16,600 tons. 40,200 tons
Structural steelwork in main bridge without lower deck	73,000 tons
Masonry, New Jersey tower foundation	37,500 cu. yds.
Masonry, New York anchorage	165,000 cu. yds.
Rock excavation, New Jersey anchorage and approach	300,000 cu. yds.

Apart from what might be termed its local service, the George Washington Bridge forms an important link in the roads planned for the comprehensive development of transportation facilities at the Port of New York as a whole, and it is in a position that will enable it to serve as a vital connection between a number of national highways. It offers direct and expeditious access from northern New Jersey and parts of New York State west of the Hudson River to New York City. It will also act as an artery for traffic between New England and the Atlantic seaboard southward, affording a route that makes it possible to avoid the more congested sections of Manhattan Island. In conjunction with the Washington Bridge across the Harlem River and the projected Tri-Borough Bridge across the East River, the George Washington Bridge will establish a new highway between Long Island and New Jersey.

Like all kindred interstate structures built or being reared by the Port of New York Authority, the George Washington Bridge was

Photos, Ewing Galloway, New York

George Washington Bridge in service viewed from tower on New York side of the Hudson River.

On day after formal opening no fewer than 56,312 cars and 100,000 pedestrians used the bridge.

authorized by legislative acts of the states of New York and New Jersey and approved by the Congress. The Legislation that committed the project to the Port Authority recognized that the bridge, although to be paid for out of tolls, was for the benefit of the people of the two states. The Port Authority, therefore, has performed in its building and will continue to perform in its maintenance and operation a governmental function.

The method of financing should be of interest the world over to other governments or organizations contemplating similar ventures. The states of New York and New Jersey agreed to advance to the Port Authority a total of $10,000,000, in five equal annual installments, to meet part of the construction cost. For completing the financing, the Port Authority issued $50,000,000 of Port of New York Authority, New York-New Jersey Interstate Bridge Gold Bonds, of which $20,000,000 worth were sold December 9, 1926, and the remaining block on November 1, 1929. The bonds are secured by a first lien on the revenues to be derived from the operation of the bridge. The moneys advanced by the two states will be repaid them, with interest.

In order to obtain the advantages of low initial cost, early opening to traffic, and flexibility that would permit adapting the facilities to future requirements, the bridge was inaugurated with only part of its traffic ways completed. That is to say, the deck has been provided for the time being with two sidewalks and only four lanes for vehicular traffic. When circumstances warrant, it will be given four additional vehicular lanes and a lower deck will be constructed that will be able to carry four rapid-transit tracks. The bridge, as it stands today, represents an outlay of something less than $60.000.000. The estimated ultimate cost is $75,000,000.

Many of the details concerning this engineering triumph were given in the February, 1931, issue of *Compressed Air Magazine;* and, therefore, no mention of them need now be made here. We do feel, however, that there is ample reason at this time for congratulating every one in any way responsible for the successful consummation of the project. On behalf of the Port of New York Authority, the work was supervised from start to finish by the Department of Engineering, as follows: O. H. Ammann, chief engineer; Edward W. Stearns, assistant chief engineer; Allston Dana, engineer of design; J. C. Evans, terminal engineer; and Montgomery B. Case, engineer of construction. The consulting organization consisted of William H. Burr, Daniel E. Moran, Joseph B. Strauss, Leon S. Moisseiff, Lewis Buckley Stillwell, and Ole Singstad, engineers; and of Prof. Charles P. Berkey, geologist. Cass Gilbert was the architect.

SYNTHETIC LUBRICATING OILS

AS THE result of laboratory work, says the *Industrial Bulletin*, there are now available synthetic lubricating oils that possess an unusually low specific gravity and a high flash point. They flow at very low temperatures because they contain no wax, although, strange to say, the best of the raw materials used in their manufacture is the wax that is obtained in the production of natural lubricating oils. This wax must be removed from the crude-oil fractions to assure a satisfactory commodity.

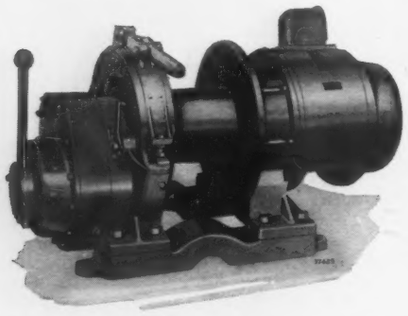
The viscosity of the synthetic oils changes less with temperature than does that of any natural oil, thus making them peculiarly applicable wherever extremes in temperature are experienced in service. For this reason, and because they are highly resistant to sludge-forming oxidation, they are especially suitable for lubricating airplane engines.

Identifying colors for cylinders charged with harmful gases in common use have been listed in a specification issued by the British Engineering Standards Association. Yellow is the designating color chosen for poisonous or toxic gases, and red for inflammable gases. Cylinders of monoxide gas, which is both combustible and poisonous, are to be distinguished by a red band on a yellow background.

NEW PORTABLE ELECTRIC HOIST HAS WIDE FIELD OF USE

THE Ingersoll-Rand Company, 11 Broadway, New York City, has added to its line of portable hoists a non-reversible, single-drum electric hoist designed for many applications in the mining, contracting, and industrial fields. Within the limits of its capacity, it is suitable for all single-cable work such as hoisting timbers, pipe, tools, and muck; for hauling and spotting cars; and for scraping.

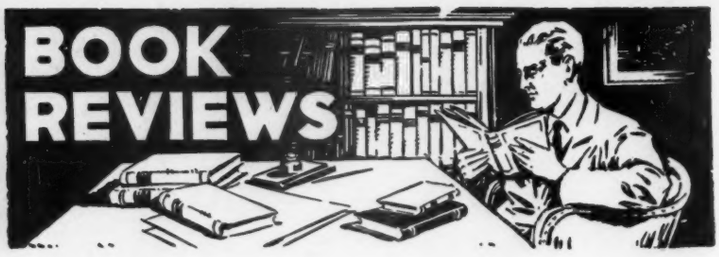
The new hoist is made in two sizes, and is modeled after the company's "Utility" type of hoist with the exception that it has an electric motor and a friction clutch instead of an air motor and a jaw clutch. No. 107 is of 7½ hp. and rated at 2,000 pounds pull at 125 feet per minute. It has a drum capacity of 400 feet of ½-inch cable or 700 feet of ⅜-inch cable. No. 107L is of like power but has a drum capacity of 800 feet of ½-inch cable or 1,400 feet of ⅜-inch cable. Hoists Nos. 110 and 110L are both equipped with a 10-hp. motor and are rated at 2,000 pounds pull at 165 feet per minute. The former has the same drum capacity as No. 107 and the latter as No. 107L.



The new portable, single-drum electric hoist.

These new electric hoists are simple, rugged, and compact; are easily operated; and have smooth control and graduation of speed. They are provided with a self-energizing brake for stopping and holding the load and with an automatic drum lock for added safety when handling suspended loads. Moving parts are protected by dustproof construction. Bases are drilled and grooved for either column mounting or bolting to a flat surface. Direct-current or alternating-current motors can be furnished to suit requirements.

The Steel Founders' Society of America, Inc., has announced the establishment of an engineering department under the direction of an experienced metallurgist and engineer to provide consulting service to mechanical engineers, designers, and others engaged in the selection and application of metals for products of all kinds. According to Granville P. Rogers, the managing director of the society, the service is offered free of charge. Inquiries should be addressed to the Development Engineering Department, Steel Founders' Society of America, Inc., 420 Lexington Avenue, New York, N. Y.



UNDER THE NORTH POLE, by Sir Hubert Wilkins. An illustrated volume of 347 pages, published by Brewer, Warren & Putnam, New York. Price, $3.00.

DESPITE the fact that the expedition foretold in this book neither reached its goal nor achieved the purpose of its projectors, still it is of unimpaired interest because it recounts much with which the public at large is unfamiliar. A good many of us have wondered why Sir Hubert Wilkins tried to journey under the polar ice; and most of us are still puzzled about what would be the practical results of such a hazardous voyage. The book tells how the idea developed; what were the worth-while objects of the expedition; and how an obsolete United States Navy submarine was to be adapted for the venture.

Although Sir Hubert's gallant endeavor failed, nevertheless the book discloses the reasonableness of the undertaking and what would be some of the gains from a voyage of that kind. Looking back instead of forward, as we can now, it is clear that the explorer was too heavily handicapped by the weaknesses of the particular submarine used for the experiment. Some day another craft will be equipped for a second venture, and then possibly all the things hoped of the revamped *Nautilus* will be realized. The reading of Sir Hubert's book now will make the next attempt understandable.

MUSTAPHA KEMAL OF TURKEY, by H. W. Wortham. An illustrated volume of 251 pages, published by Little, Brown & Company, Boston. Price, $2.50.

THE world at large had long looked upon Turkey as the personification of all that typified oriental conservatism and resistance generally to the march of modern progress. For centuries Turkey adhered to governmental and social practices that had seemed to satisfy the nation as a whole. That state of affairs might have continued indefinitely had not Mustapha Kemal come upon the scene. He has represented the leaven which has transformed Turkey and made her modern and different in so many ways—all the changes wrought under Kemal's leadership making for the betterment of the country and her elevation in the eyes of the world—judged by generally accepted standards of progress.

Mustapha Kemal would not have had the confidence of his people had he not been the most outstanding general in the Turkish army during the World War. Step by step he rose to leadership through tests covering a protracted series of national crises; and when Turkey was defeated in 1918, he promptly responded to the demand for a strong man to point the way. By appealing to the patriotism of his fellow countrymen he inspired them with a new purpose and a new force; and, after the Sultanate and Caliphate were abolished, Kemal organized and headed the People's Party. Next followed a series of momentous reforms; and the outcome of these is New Turkey. The author has drawn an absorbing and a convincing picture of Mustapha Kemal and his advance to the position he now enjoys as a world figure of great significance.

WORLD MINERALS AND WORLD POLITICS, by C. K. Leith. A book of 213 pages, published by Whittlesey House, McGraw-Hill Book Company, New York. Price, $2.00.

THIS book carries a message of vital concern to everyone of us. It is not a treatise on metallurgy but a volume replete with amazing revelations about the ever-growing demand for metals of many sorts and the manner in which they concern each of us and affect international relations. The majority of us have given little if any heed to our dependence upon different sorts of metals in meeting the decidedly complex requirements of modern industrial and social life; but thanks to Doctor Leith we have placed before us a startlingly vivid picture of the present-day meaning of these metals, and how an abundance of some of them and a lack of others in different countries inevitably lead to international relations that are fraught with grave potentialities.

As the author expresses it: "For the first time in history it is now possible to appraise the world's mineral resources with some approach to accuracy, to anticipate the lineaments of the world mineral geography of the future, and to recognize some of the political implications in the situation". And he further writes: "In the following pages the attempt will be made to outline as simply as possible the principal elements of the new picture, with a view of tracing tendencies and policies in actual operation and pointing out what seem to be the main political problems, national and international, for the future".

CHEMICAL ENGINEERING CATALOG, 1931 edition. An illustrated volume of 1,017 pages, published by the Chemical Catalog Company, Inc., New York City.

THIS is the sixteenth edition of this well-known compendium widely used by laboratories and plants engaged in the handling and manufacture of chemical products of all sorts and kinds. As a guide to the buyers of equipment and apparatus in this field of industry, this catalogue is of much value. The compilers have made the volume complete and up to date in all its departments.

Keep his head up
and we'll all come through!

You recognize this man. He lives in your own town, not far from you . . .

Though faced with unemployment, he is combating adversity with courage. He has retreated step by step, but fighting. He has spread his slender resources as far as they will go.

This winter he and his family will need your help.

There are many other heads of families much like him in the United States. This winter all of them will need the help of their more fortunate neighbors.

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By doing so we shall be doing the best possible service to ourselves. All that America needs right now is courage. We have the resources. We have the man power. We have the opportunity for world leadership.

Let's set an example to all the world. Let's lay the foundation for better days that are sure to come.

The President's Organization on Unemployment Relief

Walter S. Gifford

WALTER S. GIFFORD, DIRECTOR
Committee on Mobilization of Relief Resources

Owen D. Young

OWEN D. YOUNG, CHAIRMAN

The President's Organization on Unemployment Relief is non-political and non-sectarian. Its purpose is to aid local welfare and relief agencies everywhere to provide for local needs. All facilities for the nation-wide program, including this advertisement, have been furnished to the Committee without cost.

COMPRESSED AIR MAGAZINE

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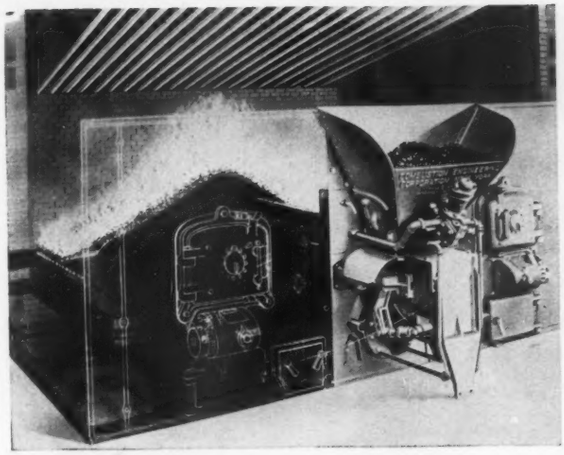

Phantom view of Type E Stoker showing fire on rear part of grate.

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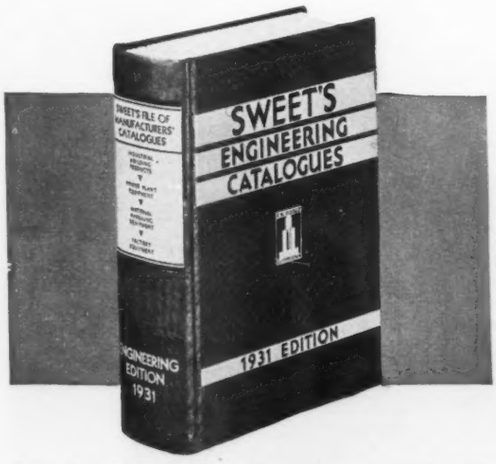

For a description of this stoker see your copy of SWEETS ENGINEERING CATALOGUES, *in which is filed the Combustion Engineering Corporation Condensed Catalog of our smaller equipment. For a comprehensive description send for our 28 page catalog "Type E Stoker".*

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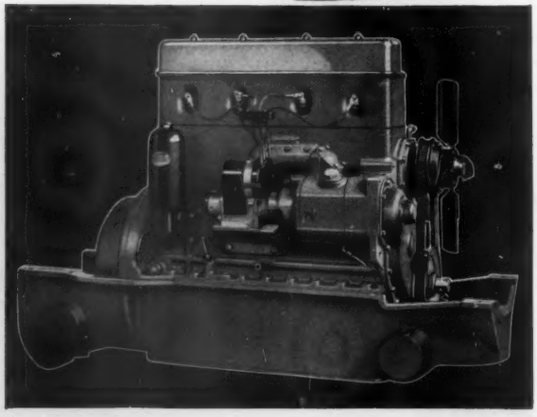

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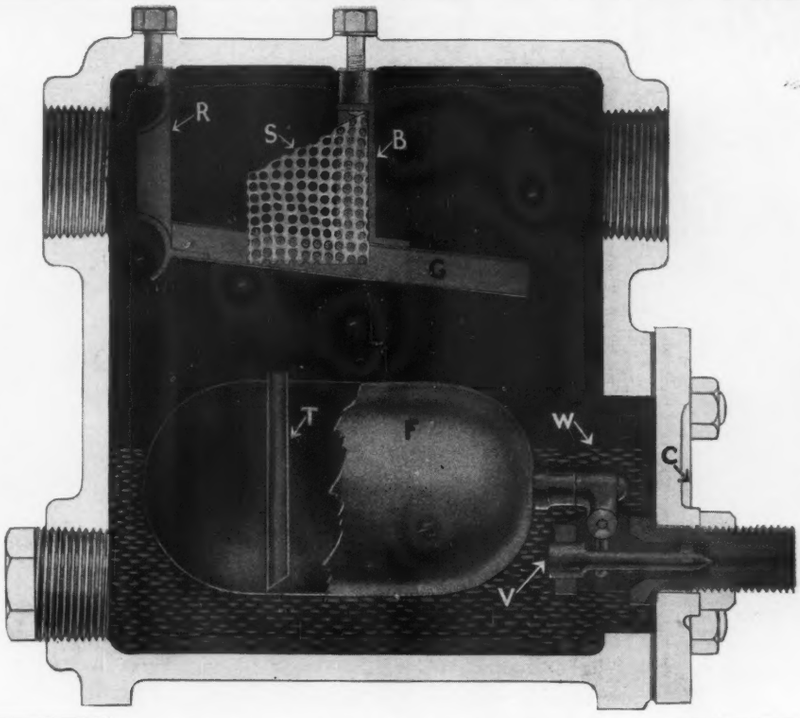

F—Non-collapsible Self-bailing float, operating bell-crank lever and valve.

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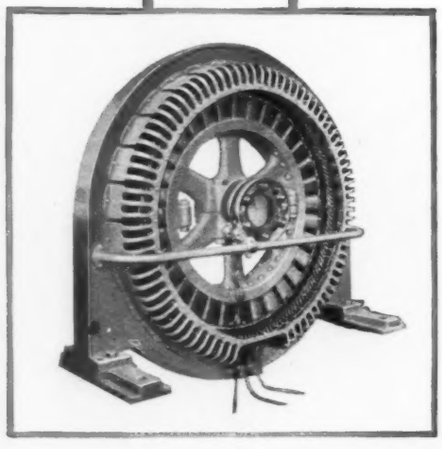

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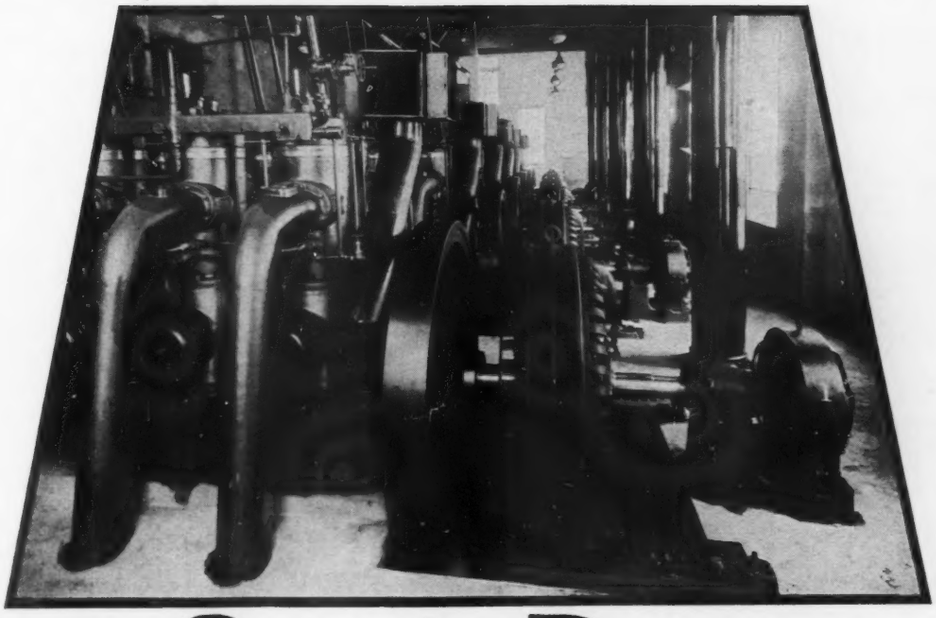

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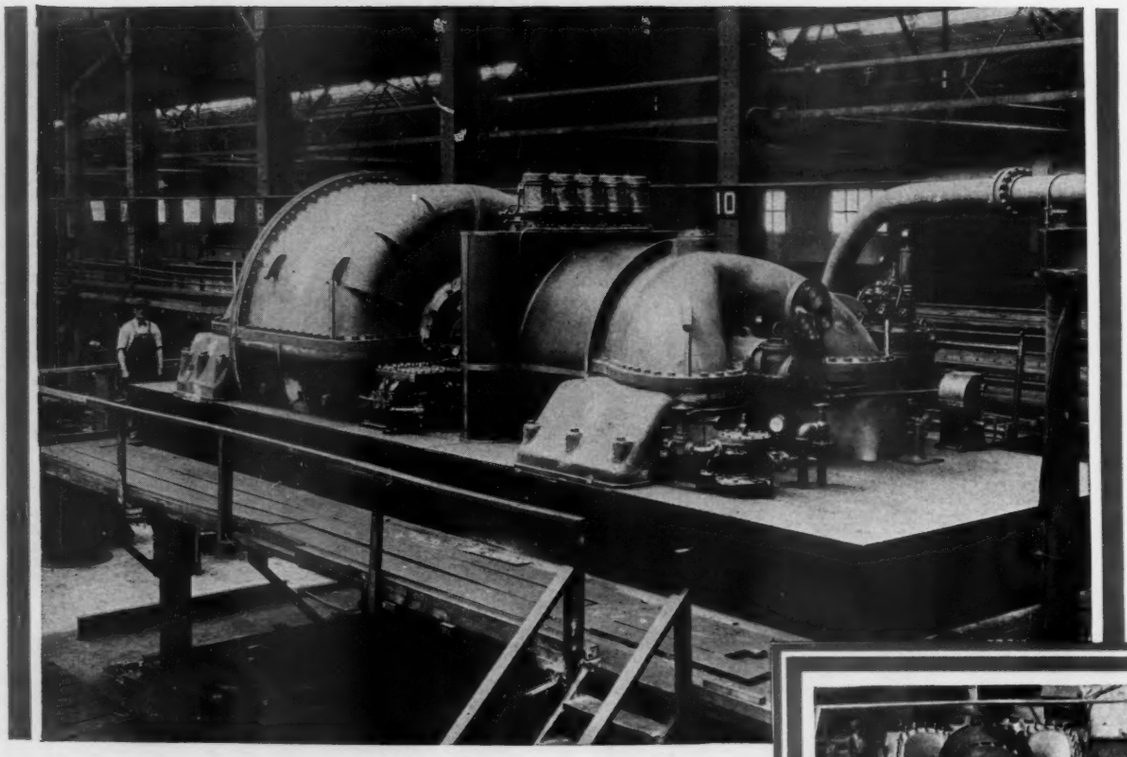

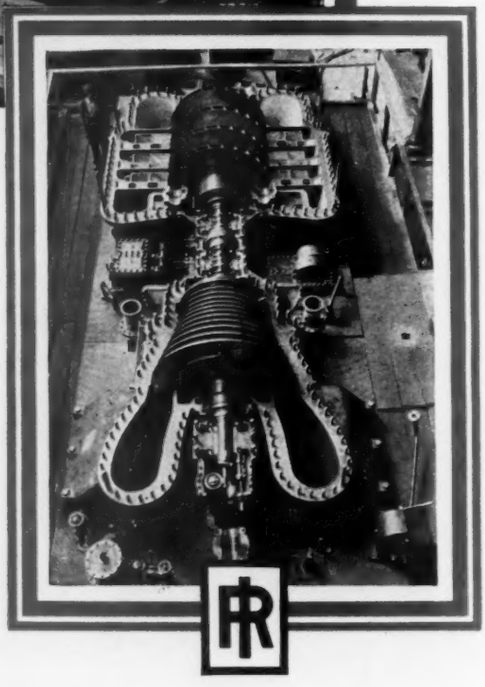

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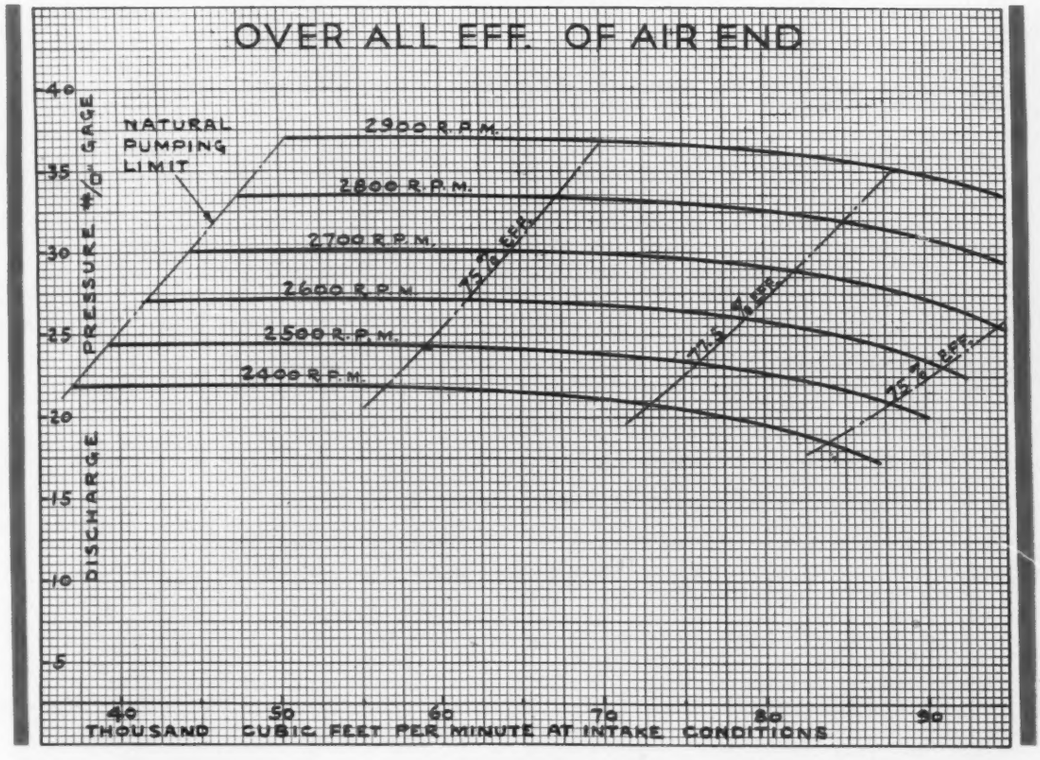

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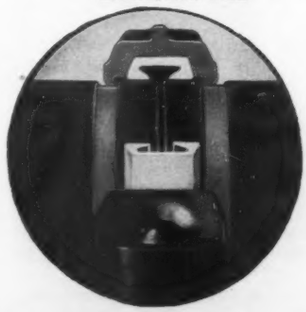

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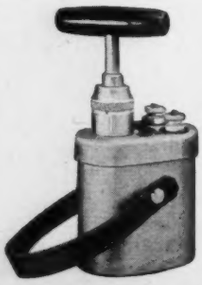

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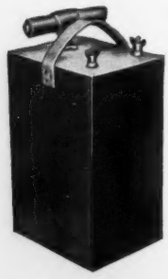

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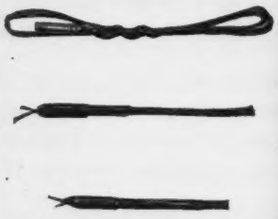

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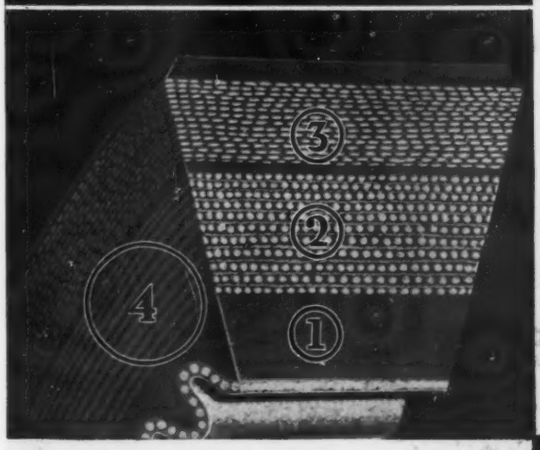

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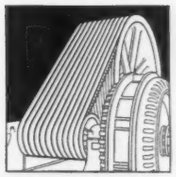

Today's lower price levels make necessary the elimination of waste in every form. Production costs must be lowered. In the important field of power transmission, production managers are turning to Dayton Cog-Belt Drives to effect revolutionary economies.

For Dayton Cog-Belt Drives save the constant replacement costs and servicing charges that ordinary drives entail. They're far more ruggedly built. They have longer life. And that's not all. They're far more efficient. The accurately die-cut belts do not slip in the pulley grooves. Therefore, exact speed ratios are maintained through greater gripping power. This means more uniform—and far cheaper—production.

Then, too, Dayton Cog-Belts are "Built to bend"—easily, without heating, at high speeds. Their pre-stretched construction and mechanical design eliminate the necessity for constant "take-ups." No lubrication or dressing is necessary.

But these are only a few of Dayton's outstanding advantages. Let us give you the whole story of Dayton features that provide more dependable, more productive and profitable operation for your machinery. Remember, there is a Dayton Cog-Belt Drive for every type of machine, from the lightest to the heaviest.

Send for a Dayton Cog-Belt Catalog and sample section of the belt . . . now.

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High Output +

Low Cost per Yard =

PROFITS

A matter of the RIGHT *machine*

Bucyrus-Erie offers you this *right* machine.

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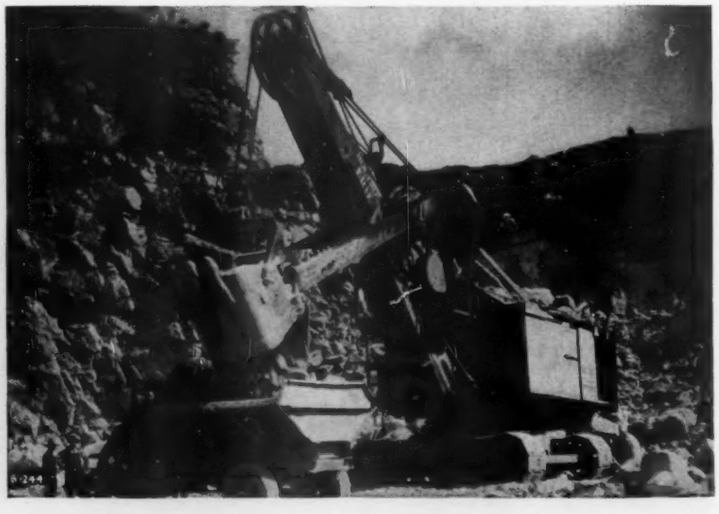
When you buy a Bucyrus-Erie, you also buy a working alliance with the largest and most experienced group of excavating equipment engineers in existence.



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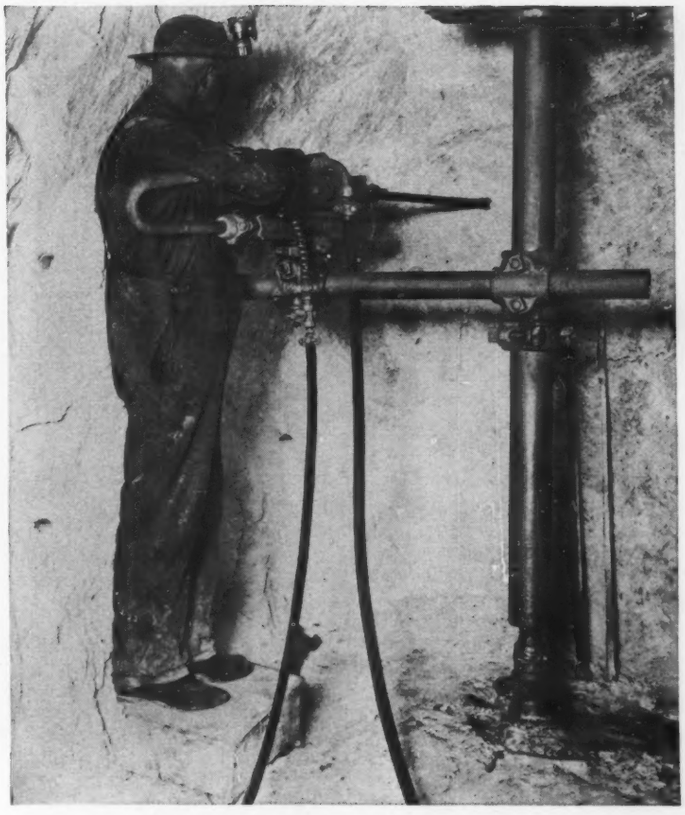
Got a Hard Pneumatic Job?

HERE'S YOUR HOSE!



Goodyear makes a tough, green-covered hose that will master the hardest pneumatic job ever lined up.

Goodyear Emerald Cord Air Hose — unequaled in rock and metal work — by long odds the staunchest air hose on the market today.

Its central tube is scientifically compounded to resist both warm and cold lubricating oils.

Multiple braided cords — firmly bound in rubber of the highest quality — rigidly withstand high pressures and resist vibration.

A tough cover of special construction withstands abrasion and surface abuse with a stoutness that far surpasses ordinary hose.

Goodyear Emerald Cord Air Hose is one of the Goodyear products specified to the job by the G.T.M.—Goodyear Technical Man. He can be of expert help to you in choosing the right types of air hose and belting for better, more economical operation. Just write to Goodyear, Akron, Ohio, or Los Angeles, California, and ask the G.T.M. to call.

Tube especially compounded to resist lubricating oils
Multiple double braids of cord – extra resistance to burst and vibration
Special construction hide–tough and firm
GOODYEAR
AIR

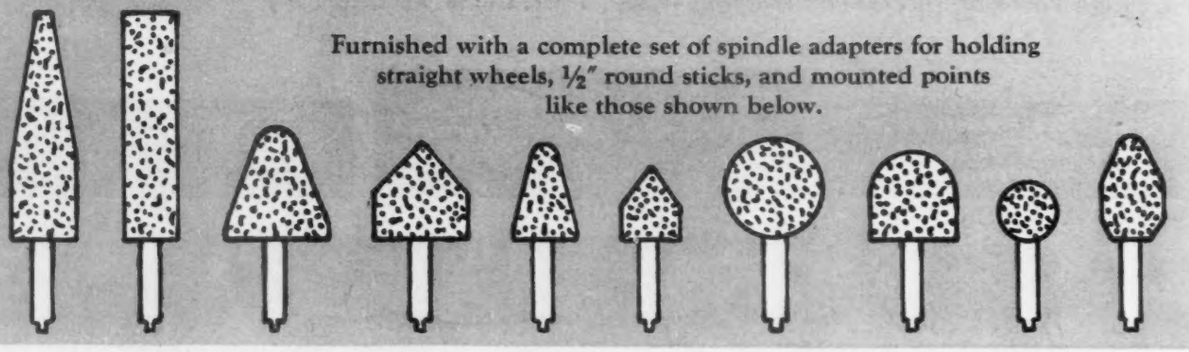
The *New* ROTOR DIE GRINDER

A production tool
built for hard service

Powerful!
Light!
Fast!

Over ½-Horsepower

Capacity .	1½" Dia. Vitrified Wheels
	2½" Dia. High Speed Wheels
Speed	18,000 R.P.M.
Weight	3 pounds
Overall Length	12 inches



Furnished with a complete set of spindle adapters for holding straight wheels, ½" round sticks, and mounted points like those shown below.

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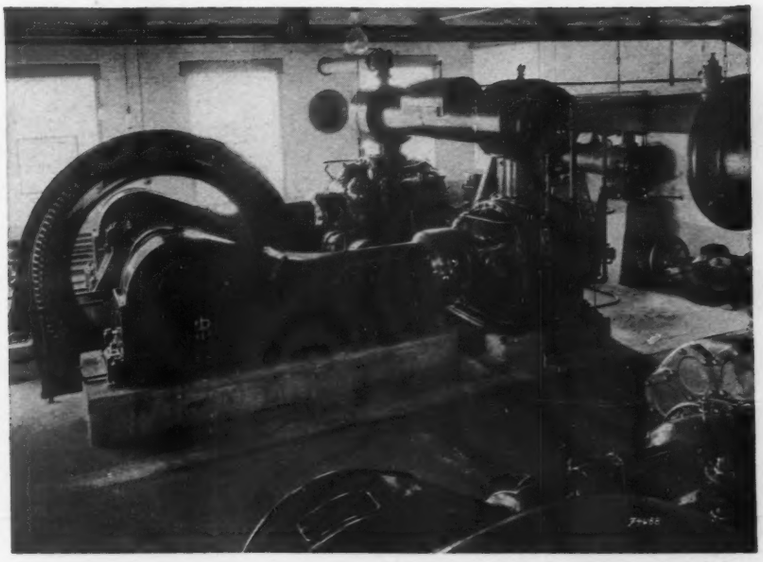
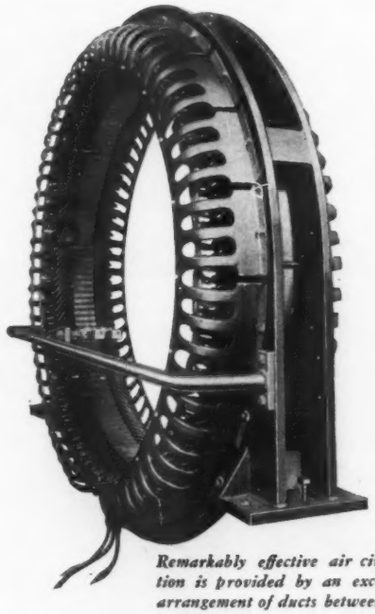
The Rotor Air Tool Co., Cleveland, Ohio



Ingersoll-Rand Air Compressor driven by a Westinghouse Synchronous Motor, at the Franklin Plant of the New Jersey Zinc Co.

MOTORS THAT LIVE *to a ripe old age . . .*



Remarkably effective air circulation is provided by an exclusive arrangement of ducts between core and frame.

WHETHER your compressor motor will have a trouble-free life of ten, twenty, or thirty years depends to a great extent upon the effective life of the coil insulation.

High localized temperatures in the motor windings, often called hot spots, will rapidly deteriorate ordinary insulation until it ceases to be an insulator. Then—perhaps in the midst of the busy season—a compressor goes out of commission until the motor is rewound.

Westinghouse HR synchronous motors have a double assurance of long life without insulation breakdown. Mica—which never deteriorates from heat—is used in the slot portion of all coils. Also, directed air circulation, a principle first introduced by Westinghouse, provides effective cooling for all parts of the motor where heat is generated.

There are other good reasons why Westinghouse compressor motors will live to a ripe old age. Write our nearest office for a copy of Leaflet 20333-A which gives complete information.

Service, prompt and efficient, by a coast-to-coast chain of well-equipped shops

Westinghouse

T 31945

Size 10 x 8 portable compressor stationed just above Black Canyon to supply air for road build.ng

A Pioneer on the Hoover Dam Job

Before Six Companies, Inc. could start actual work on the Hoover Dam, they had to build roads through solid rock to reach the various points of work in Black Canyon. Eighteen Ingersoll-Rand portable air compressors supplied power for the rock drills that blazed these trails for workmen and machinery to follow.

I-R compressors, rock drills, and other equipment were selected for this 7-year, $49,000,000 Hoover Dam contract on the basis of their long record of reliability and efficiency in the mining and construction fields.

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Will not stick. No contamination of fluids from valve lubricants. Leakless valve seats protected at all times. Discs pressure sealed, whether valve is closed or in operating position. Permits throttling. Easy to operate. No packing. No tapered plugs.

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Craftsmanship and engineering excellence applying a new valve principle tested over seven years assure a more perfect Valve product than ever produced elsewhere. In standard Straight-way, 3-Way and 4-Way styles, NOPAK Valves (no packing) made from ¼" to 2" pipe openings. Special sizes and port arrangements on request.

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There is nothing more wasteful and annoying than a leaking, sticking, hard operating plug valve.

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is of the flat disc, regrinding type, with the disc and seat made of non-corrosive metals. They operate easily and do not leak. Made in all sizes from ¼" to 1½".

W. H. NICHOLSON AND CO.

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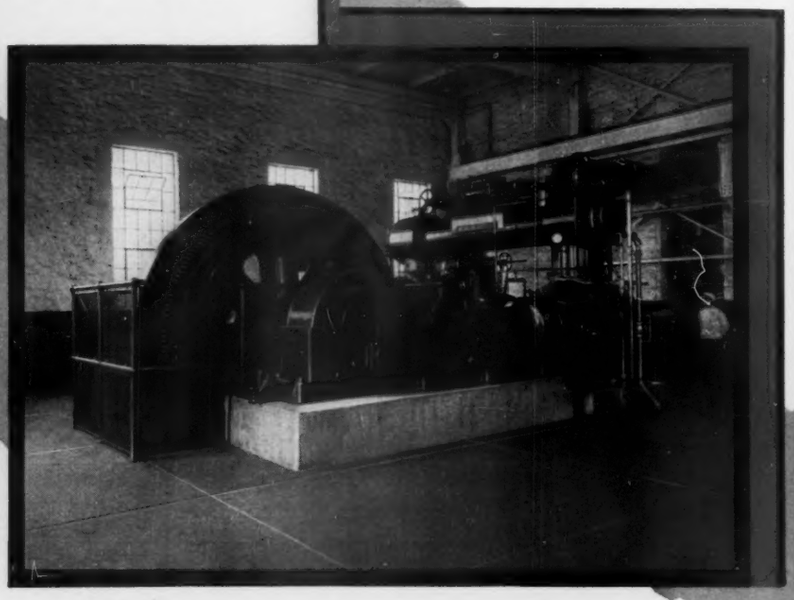
Left—Ingersoll-Rand X-71 drills preparing anchorage for cables on New Jersey side.

Below—Class "PRE-2" compressor, the type of unit that furnished air for drilling the New Jersey anchorages.



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an outstanding achievement

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It was made possible only through the unified efforts of many organizations and countless individuals. It is the product of thousands of brains and muscles.

Recognition of the important parts they played is due all concerned, from the Port of New York Authority which conceived it, planned it, financed it, and directed its construction, down through the various contractors to the army of workmen who produced and fabricated the materials.

Ingersoll-Rand Company was privileged to assist in this notable enterprise. Virtually every one of our diversified group of products came into use, either at the bridge site or in preparation and transportation of materials.

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Air Compressors. Rock Drills Oil-Electric Locomotives

Top—George Washington Bridge, viewed from the New York side. Bottom—Ingersoll-Rand "Jackhamers" and portable air compressor building one of the roads that will connect with the bridge in New Jersey.

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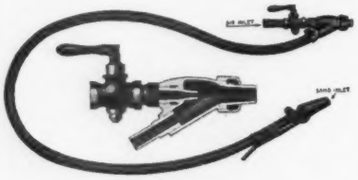

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Eliminates 75 to 85% wear

It costs $100.00 or more to pull down the average sized compressor, clean the parts and replace them. As Protectomotor Air Filter equipped machines operate 3 to 5 times longer before overhauling is needed, the Protectomotor usually saves hundreds of dollars a year in repair bills alone. In addition, it cuts oil consumption 25%, saves compressed air and muffles the noise of compressors and vacuum pumps.

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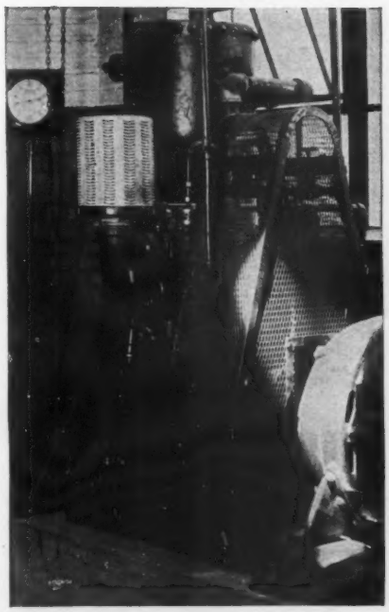

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Standard equipment on type ER Ingersoll-Rand Compressors

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On Ingersoll-Rand Type ER Compressors, Texrope Drives are standard. You can well afford to investigate their use on other machines. Their positive pull and shock-absorbing qualities have resulted in increased production and longer life of machinery of all kinds. Over 125,000 Texrope Drives are now in service. They are saving money for some 25,000 users.

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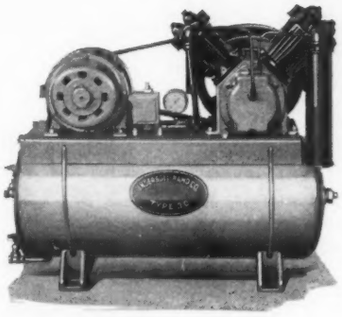

Type 30, complete with receiver, available in many sizes.

INGERSOLL-RAND builds more than 1000 different types and sizes of compressors. They range in piston displacement from 3 to more than 30,000 cubic feet per minute. They include units for handling air or gas under any pressure conditions. Any commercial type of drive is available.

But, throughout this extensive line of machines, there runs just one quality—the best. From the smallest unit to the largest, careful attention is paid to design, materials, and workmanship. The accumulated experience of Ingersoll-Rand in the manufacture and operation of compressors of all types and capacities over a period of 60 years is reflected in every machine turned out.

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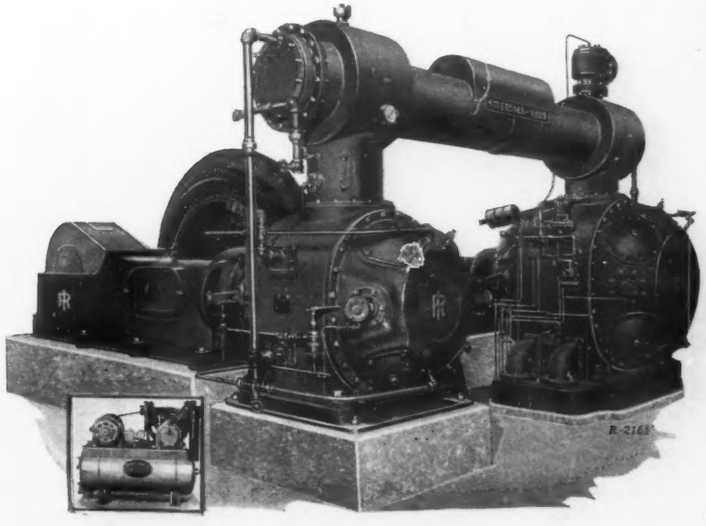

Class "PRE" direct-connected, synchronous-motor-driven unit. Made in sizes ranging from 208 to 1,270 horsepower. This view and the inset show the comparative sizes of the smallest Type 30 and largest Class "PRE".

1033-C

Ingersoll-Rand

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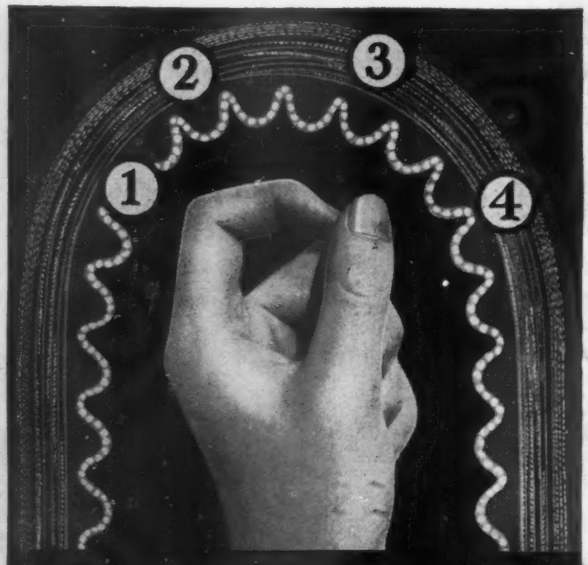

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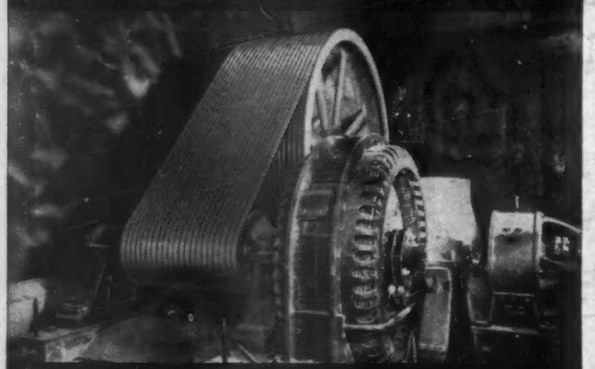
BEND AS EASILY—AS NATURALLY
AS YOU BEND YOUR FINGER!



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IN STOCK. ALL RATIOS, 2 H. P. TO 100 H. P.

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2 The "Neutral Axis"... the strength section... permanently pre-stretched by Dayton's patented process.

3 The Outer Section... gives balance... is composed of layers of vulcanized, strong cord fabric, bias-cut to accommodate bending without strain or distortion.

4 The entire belt is die-cut for precision and greater gripping power. Daytons are accurate and stay accurate.

Standardize on Dayton Cog-Belt Drives and you'll modernize your equipment for power transmission. You'll save space. You'll get positive speed control. You'll secure more uniform operation and get better results at less cost. You'll eliminate the cost of many hours' servicing on belts and bearings. You'll reduce the number of shut-downs on account of transmission troubles to a minimum. You'll have a quieter, cleaner, better arranged plant when you use Dayton Cog-Belt Drives.

You can easily identify Dayton V-Belts by their cog construction, for Daytons are the only *Cog* V-Belts made. This cog feature, one of the most important improvements ever made in V-belt construction, is patented and exclusive. *Choose Cog-Belts—and you choose Daytons!*

Dayton Cog-Belts are "built to bend." And they do bend—easily, around small pulleys, at high speeds, without distortion or heating. As a result, they last longer—require less servicing—increase the efficiency of your power transmission amazingly.

Let us *prove* these facts to you. Send for a Dayton Cog-Belt catalog and for a sample section of the belt. Write—today.

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